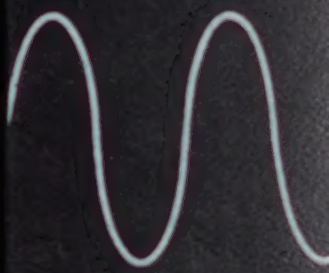

SPECTRAL DYNAMICS CORPORATION

SERIAL 363

INSTRUCTION MANUAL

SD301C

REAL TIME ANALYZER

(MODIFIED TO MODEL SD301C-39)

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ADDENDUM

Model SD301C-39 Real Time Analyzer

The Model SD301C-39 is basically a standard Model SD301C Real Time Analyzer. The "-39" in the model number denotes the following modification to the basic instrument:

The SD301C-39 is specially wired for use with the Model SD309 Ensemble Averager. In the SD301C manual, all references to the Model SD302 Ensemble Averager are applicable to the Model SD309. For details concerning the operation of the SD309, refer to the instruction manual supplied with the instrument.

The "-39" changes that were made to the Display Control Circuit Card (A16) are shown in Figure 1.

The additional wiring that was installed between rear-of-chassis connector J13 and circuit card receptacles XA17, XA18, and XA21 is tabulated as follows:

J13 Pin No.	Circuit Card-Pin No.
25	XA16-A
26	XA17-E
27	XA17-9
28	XA17-X
29	XA18-13
30	XA17-12
31	XA17-A
32	XA17-1
33	XA21-12 (coax)
34	XA17-11
35	XA17-M

Also, the ground was removed from J13-24, and XA16-1 was connected to ground. These wiring changes addend the Main Frame drawing in the basic manual.

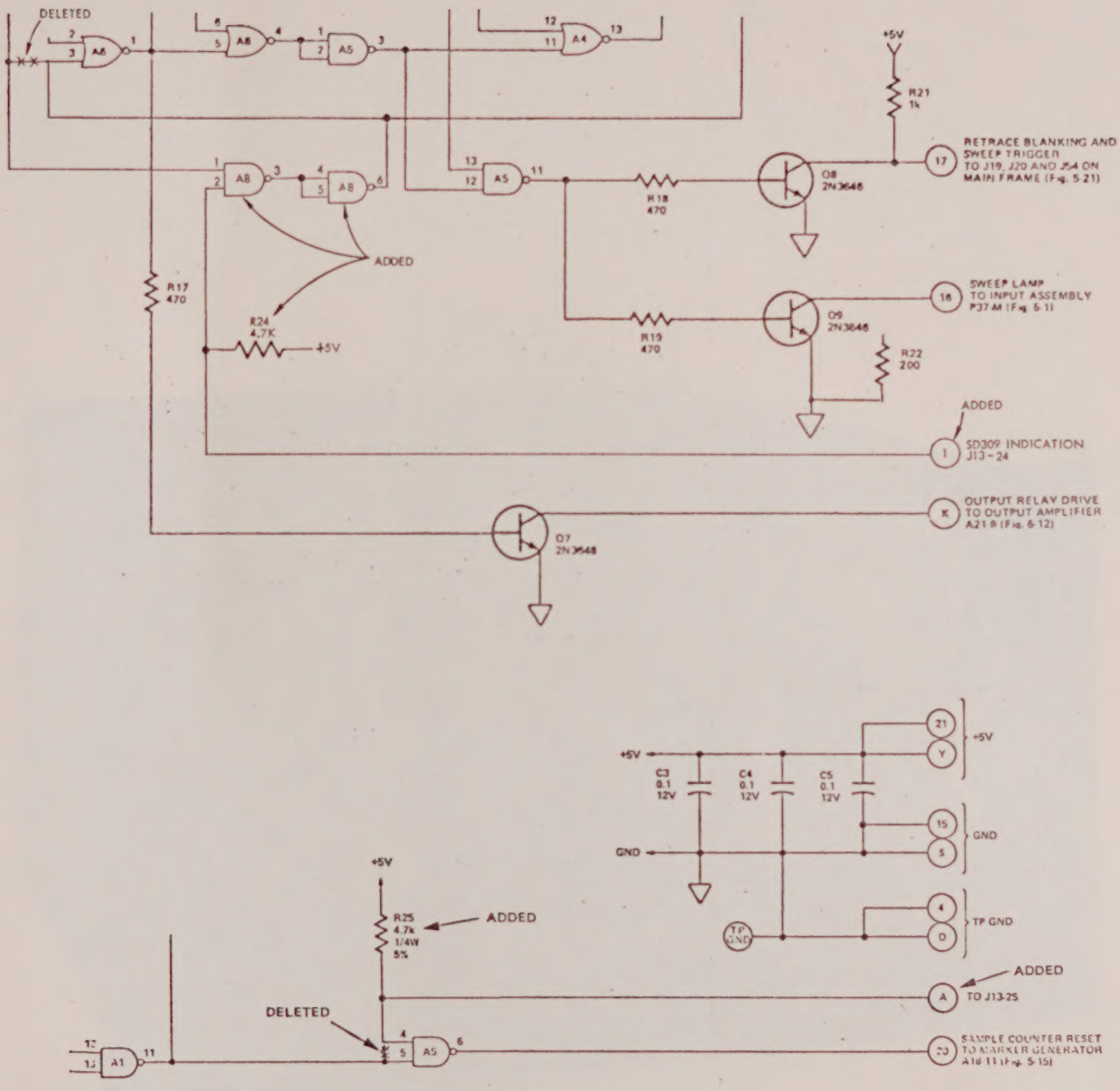
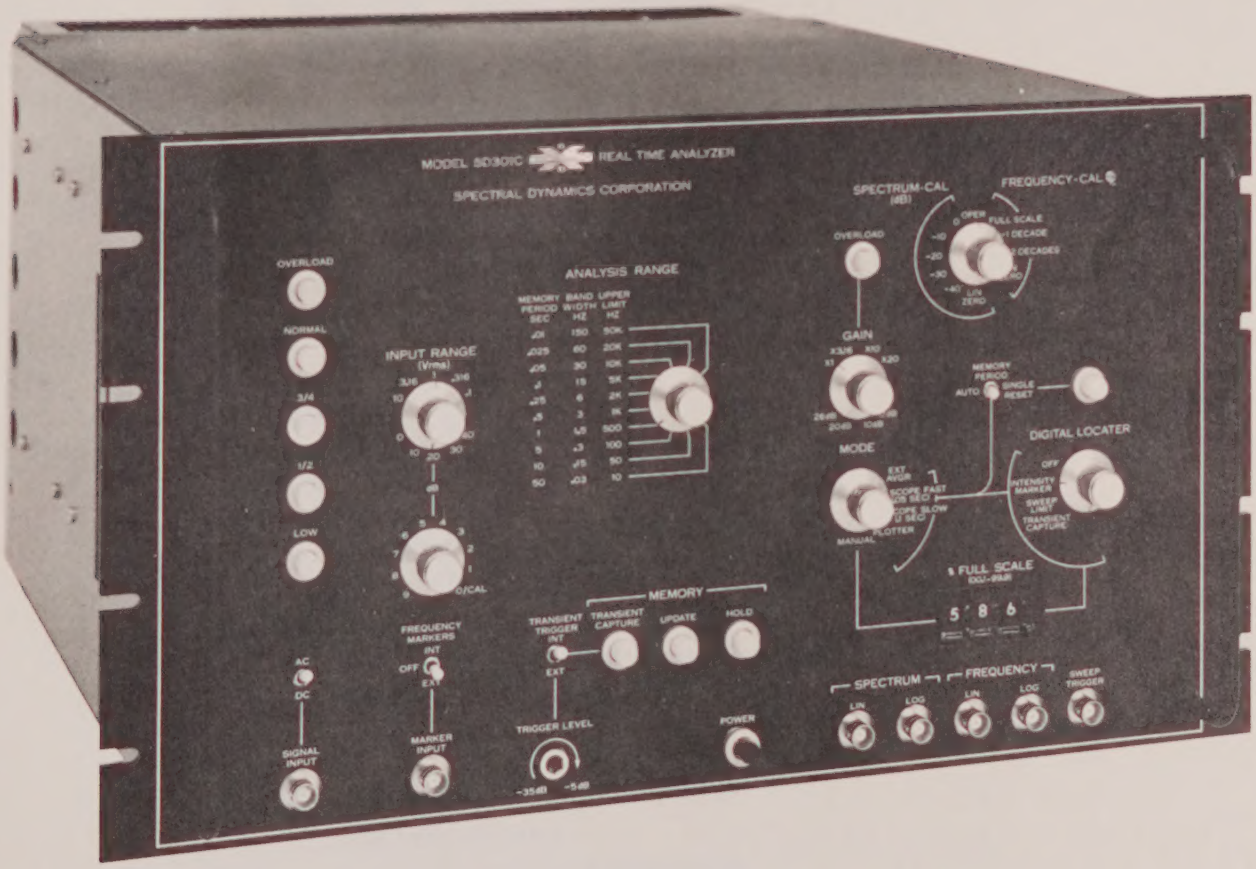


Figure 1. "-39" Changes to Display Control Circuit Card A16



MODEL SD301C REAL TIME ANALYZER

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TABLE OF CONTENTS

SECTION			PAGE
I	GENERAL INFORMATION		
	1.1	Introduction	1-1
	1.2	Concept of Operation	1-1
	1.3	Front Panel Functional Description	1-3
	1.4	Rear Chassis Functional Description	1-13
	1.5	Specifications	1-17
II	OPERATION		
	2.1	General	2-1
	2.2	Initial Powering Procedure	2-1
	2.3	Operational Checkout Procedure	2-1
	2.4	Setup Instructions for Using Oscilloscope or X-Y Recorder	2-9
	2.5	Connector Functions	2-12
	2.6	Analysis of a Periodic Signal	2-13
	2.7	Analysis of Acoustic Data	2-15
	2.8	Analysis of Random Data (PSD)	2-18
	2.9	Transient Analysis	2-27
	2.10	Narrowband Spectrum Resolution at Frequencies to 1 MHz	2-30
	2.11	Sonic and Vibration Analysis of Rotating Machines	2-31
	2.12	Spectrum Lin Squared Output (Optional)	2-31
	2.13	External Sampling and Tape Speed Normalization	2-31
	2.14	Extended Upper Frequency Coverage	2-32
III	CONCEPT AND THEORY OF OPERATION		
	3.1	Concept of Operation	3-1
	3.2	Simplified Block Diagram Description	3-1
		3.2.1 Input Conditioning	3-3
		3.2.2 Time Compression	3-3
		3.2.3 Analyzer	3-3
		3.2.4 Sweep Oscillator	3-4
		3.2.5 Digital Control	3-5
		3.2.6 Clock	3-5
		3.2.7 Power Supply	3-5

TABLE OF CONTENTS (Continued)

SECTION PAGE

III CONCEPT AND THEORY OF OPERATION (Continued)

3.3 Detailed Block Diagram Description 3-5
3.3.1 Input Conditioning 3-6
3.3.2 Time Compression 3-6
3.3.3 Analyzer 3-11
3.3.4 Sweep Oscillator 3-14
3.3.5 Digital Control 3-17
3.3.6 Clock 3-19
3.3.7 Power Supply 3-21

IV CALIBRATION

4.1 General 4-1
4.2 Calibration Procedure 4-3
4.3 Comprehensive Calibration 4-11
4.4 Parts Replacement 4-17
4.5 Troubleshooting 4-20

V CIRCUIT DIAGRAMS AND COMPONENT IDENTIFICATION

5.1 Introduction 5-1

LIST OF TABLES

Table 2-1. J13 Connector Functions 2-12
Table 2-2. J14 Connector Functions 2-12
Table 2-3. J15 Connector Functions 2-13
Table 2-4. Memory Parameters 2-19
Table 4-1. Test Equipment Required 4-1
Table 4-2. Special Replaceable Parts List 4-17
Table 4-3. RTA Troubleshooting Guide 4-23
Table 4-4. Testpoint Waveforms 4-31

LIST OF ILLUSTRATIONS

Figure 1-1.	Concept of Operation	1-1
Figure 1-2.	Front Panel	1-2
Figure 1-3.	Rear Chassis	1-12
Figure 2-1a.	Calibration Signal	2-3
Figure 2-1b.	Intensity Marker at Peak of Calibration Signal Fundamental, MANUAL MODE	2-3
Figure 2-1c.	Frequency Markers with 10 Intensity Markers	2-3
Figure 3-1.	Concept of Operation	3-1
Figure 3-2.	Block Diagram Model SD301C Real Time Analyzer	3-2
Figure 3-3.	Functional Block Diagram of Input Conditioning Section	3-7
Figure 3-4.	Functional Block Diagram of Time Compression Section	3-8
Figure 3-5.	Block Diagram of Shift Register Memory "Delay Line"	3-10
Figure 3-6.	Functional Block Diagram of Analyzer Section	3-12
Figure 3-7.	Functional Block Diagram of Sweep Oscillator Section	3-15
Figure 3-8.	Functional Block Diagram Digital Control Section	3-19
Figure 3-9.	Functional Block Diagram of Clock Section	3-21
Figure 3-10.	Functional Block Diagram of Power Supply	3-23
Figure 4-1.	Chassis Top View	4-2
Figure 4-2.	Super-Simplified Block Diagram	4-21
Figure 4-3.	Troubleshooter's Functional Block Diagram — Model SD301C Real Time Analyzer	4-22
Figure 4-4.	Troubleshooting Tree	4-30
Figure 5-1.	Front Panel, Assembly 13712-1 (Circuit Card A32, Assembly 15048-1)	Rear
Figure 5-2.	Comparator, Assembly 14860-3 (Circuit Card A15)	
Figure 5-3.	Ladder, Assembly 12750-101 (Circuit Card A14)	
Figure 5-4.	Number Generator, Assembly 13942-3 (Circuit Card A13)	
Figure 5-5.	Digital Indicator, Assembly 11380-1 (Circuit Card A12)	
Figure 5-6.	Memory, Assembly 14996-1 (Circuit Cards A3—A11)	
Figure 5-7.	High Speed D-A, Assembly 12552-1 (Circuit Card A1)	
Figure 5-8.	Scan Unit, Assembly 15586-1 (Circuit Card A27)	
Figure 5-9.	Mixer & RTA Output Amplifier, Assembly 15312-1 (Circuit Card A26)	
Figure 5-10.	Down Converter, Assembly 11440-3 (Circuit Card A28)	
Figure 5-11.	Detector, Assembly 14992-1 (Circuit Card A29)	
Figure 5-12.	Output Amplifier, Assembly 11430-1 (Circuit Card A21)	
Figure 5-13.	18—23 MHz VCO, Assembly 15444-1 (Circuit Card A25)	
Figure 5-14.	Display Control, Assembly 12514-1 (Circuit Card A16)	
Figure 5-15.	Marker Generator, Assembly 12520-1 (Circuit Card A18)	
Figure 5-16.	Counter Control, Assembly 10080100 (Circuit Card A17)	
Figure 5-17.	Counter, Assembly 12518-1 (Circuit Card A19)	
Figure 5-18.	BCD Ladder, Assembly 01580200 (Circuit Card A20)	
Figure 5-19.	Clock, Assembly 14162-1 (Circuit Card A2)	
Figure 5-20.	Power Supply, Assembly 13980-1 Circuit Card A33, Assembly 11504-3)	
Figure 5-21.	Main Frame, Assembly 13710-1	Rear

RECEIVING INSPECTION PROCEDURE

The Model SD301C Real Time Analyzer is shipped fully assembled, packed in a polystyrene case designed to protect it against all normal shipping hazards. Immediately upon receipt, inspect the exterior of the shipping case and note any visible damage. Keep all forms and invoices attached to the shipping case. Remove the instrument from the shipping case and test its functional operation in accordance with Section II of this manual. If shipping damage is apparent, file a claim with the carrier's claims agent and send a copy to Spectral Dynamics Corporation. Be sure to include the instrument name, model number, and serial number on all correspondence. Spectral Dynamics Corporation will advise the buyer what should be done; arrangements for repair or replacement will be made as applicable.

WARRANTY POLICY

All Spectral Dynamics products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain components listed in some of the operating manuals, for the specified period. We will repair or replace products which prove to be defective during the warranty period, providing the failure or damage has not been caused by misuse or abnormal operating conditions. Fuses and lamps are specifically excluded from warranty. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate of cost to repair will be submitted to the purchaser for approval before beginning any repair work.

Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory, with transportation charges prepaid by the purchaser. No other warranty is expressed or implied. We are not liable for consequential damages.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, and the name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via air freight to the factory or authorized repair station indicated on the instructions. Replace the instrument in its original shipping case, or surround with two to three inches of shock absorbing material and then pack it in a heavy-weight cardboard box, wooden box, or other strong container.

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Model SD301C Real Time Analyzer provides "on line" spectrum analysis capability in the audio and sub-audio frequency ranges. With input frequency ranges up to 50 kHz and resolution bandwidths down to 0.03 Hz, the SD301C achieves speed increases of "orders of magnitude" over standard audio analyzers.

The Model SD301C is highly flexible in operator-selected modes of operation. The output spectra is provided in either linear or log form, fast enough for a "flicker free" oscilloscope display, or slow enough for an X-Y recorder (plotter). A memory capture mode allows a segment of input data to be stored for examination.

1.2 CONCEPT OF OPERATION

The Model SD301C Real Time Analyzer utilizes time compression techniques to achieve minimum analysis time for the frequency-tuned bandpass filter to convert the input signal from the time domain to the frequency domain. (See Figure 1-1.)

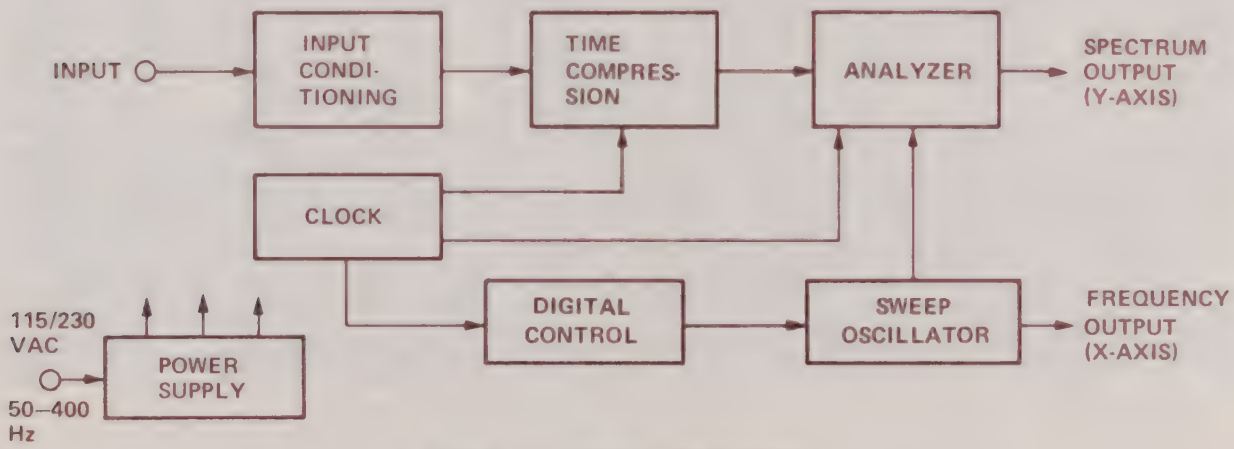


Figure 1-1. Concept of Operation

The time compressed input signal is frequency analyzed using 500 or 1000 synthesized filter locations that are tuned by a built-in sweep generator. Frequency (X-axis) and spectrum (Y-axis) outputs are provided in linear step, linear smooth, and log smooth form. An internal marker generator and calibrate signal facilitate oscilloscope and X-Y recorder calibration on all ranges. All operational modes can be controlled by application of external signals.

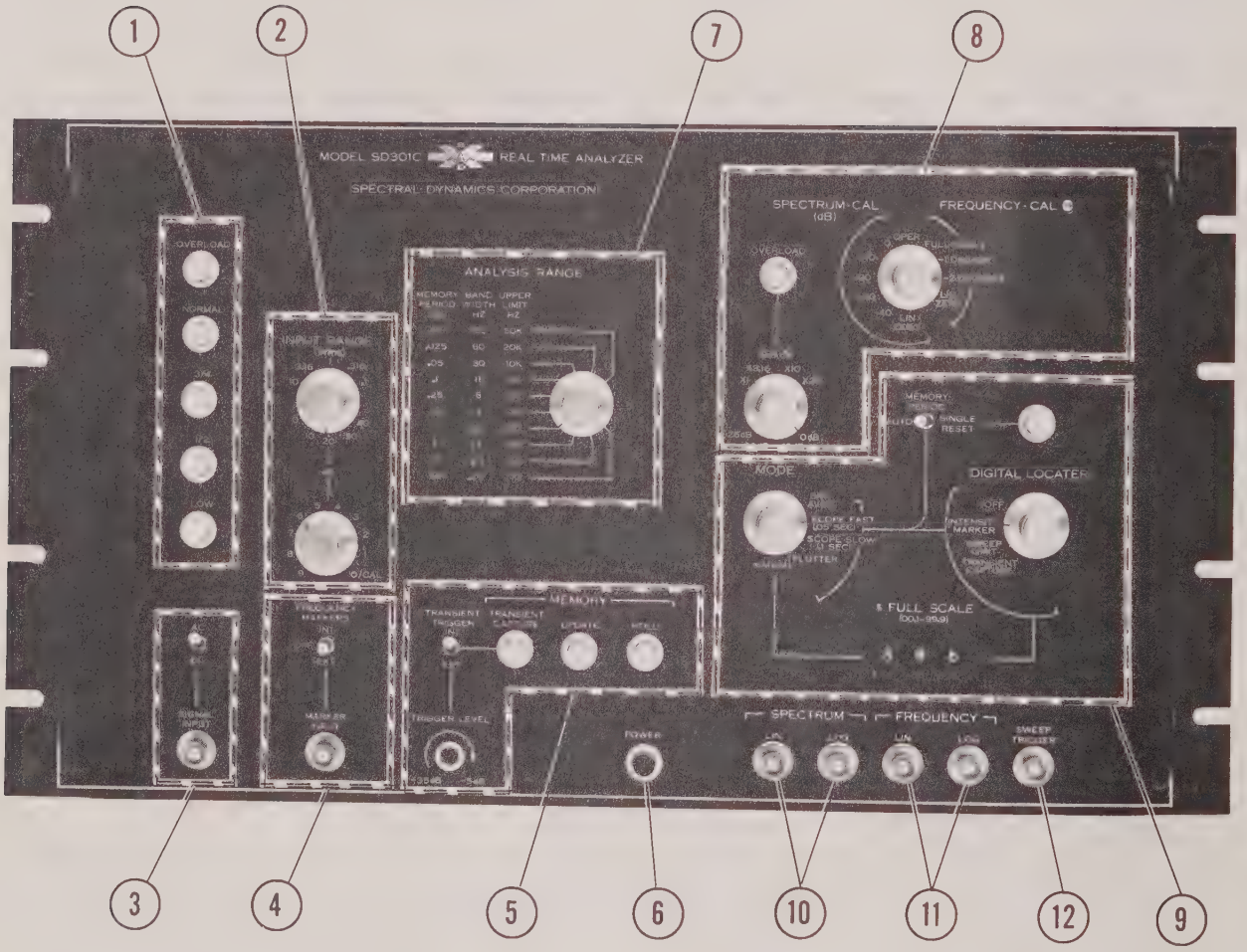


Figure 1-2. Front Panel

1.3 FRONT PANEL FUNCTIONAL DESCRIPTION

The descriptions given in the following paragraphs are keyed by circled numbers to their associated control, indicator, or connector as shown in Figure 1-2, Front Panel, Model SD301C Real Time Analyzer. All interacting controls, indicators, etc. have been grouped to maintain continuity of description.

(1) INPUT Level Indicator Group

OVERLOAD Indicator

Lights when input signal is full scale or exceeding full scale of range selected. When lighted, distortion could be present.

NORMAL Indicator

Lights when input signal is approximately 1 dB less than full scale of range selected.

3/4 Indicator

Lights when input signal is 75% full scale, or ≈3 dB below full scale of range selected.

1/2 Indicator

Lights when input signal is ≈50% full scale, or ≈6 dB below full scale of range selected.

LOW Indicator

Lights when input signal is ≈25% full scale, or ≈12 dB below full scale of range selected.

(2) INPUT RANGE (Vrms)

Coarse and fine range switches provide 0 to 49 dB attenuation of the input signal in 1 dB steps. The total attenuation equals the sum of both switch settings.

Coarse INPUT RANGE switch selects input signal range 0.1 Vrms to 10 Vrms in 10 dB steps.

Fine INPUT RANGE switch provides 9 dB range in 1 dB steps to give complete coverage between the 10 dB steps of the coarse switch settings.

(3) SIGNAL INPUT Connector, AC/DC Switch

SIGNAL INPUT connector accepts signal to be analyzed; is connected in parallel with J24, SIGNAL INPUT, on the rear chassis.

AC/DC switch selects either direct-coupled (DC) input circuit to provide flat frequency response for low frequency signals, or an a-c coupling (AC) circuit to block a d-c level that might be present on the input signal.

(4) FREQUENCY MARKERS Switch/MARKER INPUT

FREQUENCY MARKERS Switch

INT

Applies 10 equally-spaced frequency markers to the output spectrum, approximately 26 dB down from full scale.

OFF

No markers are applied to output spectrum display.

EXT

Externally applied markers are summed with the input signal to provide output spectrum frequency-reference markers.

MARKER INPUT

Accepts external signals to be used as spectrum frequency-reference markers. Input impedance is 5k ohms nominal. A 1 Vrms input provides marker display at approximately 20 dB down from full scale. This connector is connected in parallel with J23, MARKER INPUT, on the rear chassis.

(5) MEMORY Mode Switches—Indicators/TRANSIENT TRIGGER Switch/TRIGGER LEVEL Control

Pressed to select one of the following memory modes of operation. Push button lights when mode is activated.

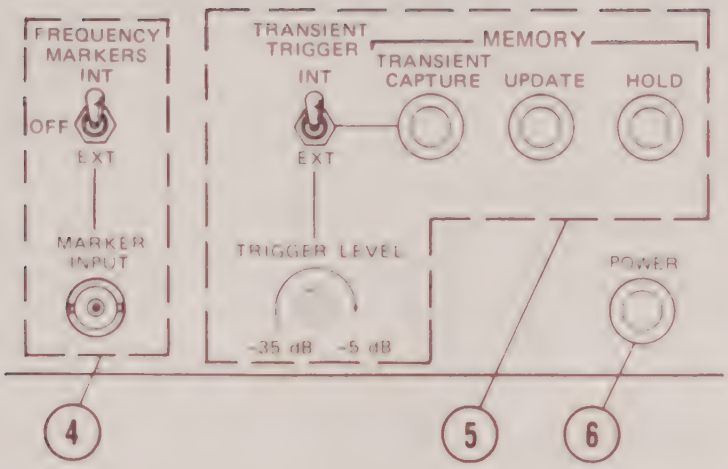
MEMORY Mode Switches—Indicators

HOLD

When activated, the contents of the memory at that time is held and continuously outputed, no new data is accepted.

UPDATE

Input signal data is sampled and applied to the memory. The data is sampled at a rate consistent with the selected frequency range.



TRANSIENT CAPTURE

When pressed, the analyzer goes into MEMORY UPDATE mode (UPDATE indicator is off) awaiting a transient capture trigger (EXT or INT). When triggered, the selected number of samples are loaded (UPDATE lamp on). Analyzer then goes into HOLD mode.

TRANSIENT TRIGGER Switch, TRIGGER LEVEL Control

TRANSIENT TRIGGER switch is used in Transient Capture mode to select INT (internal) or EXT (external) trigger. When set to INT, loading of the selected number of samples is initiated as a function of the input signal level. In EXT position, loading is initiated by application of a signal at TRIG INPUT connector J9 on the rear chassis.

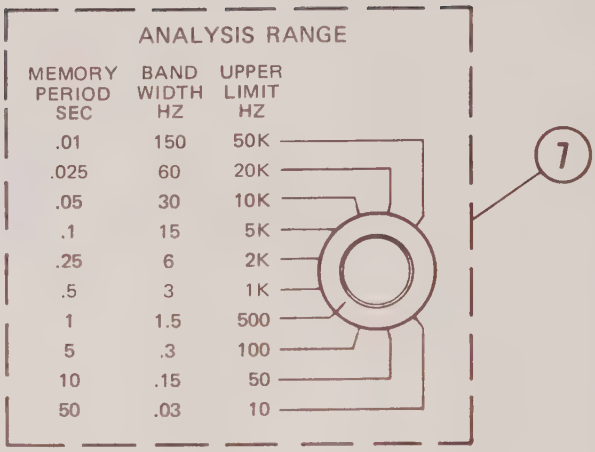
TRIGGER LEVEL control (effective in both EXT and INT modes) provides 30 dB (-5 to -35 dB) attenuation of the selected trigger signal source, EXT or INT. For normal operation in EXT mode, the TRIGGER LEVEL control is set to -5 (extreme clockwise position) and a 1V 2-microsecond pulse is applied at J9.

(6) POWER Switch/Indicator

Press to turn instrument power on or off; lighted when on.

(7) ANALYSIS RANGE

Selects analyzer upper frequency range and resolution bandwidth. The BANDWIDTH markings also denote the lowest useful frequency of each range. For each range position, a low-pass filter (with cutoff at 1.1 times the UPPER LIMIT) is inserted in the signal path, and the sampling rate (three times UPPER LIMIT frequency) is automatically selected.



(8) OUTPUT Operate Mode Group

OPERATE/SPECTRUM-CAL/FREQUENCY-CAL Switch

OPERATE

The spectrum of the applied signal is available at the output connectors in log and linear form, as selected, for display on an oscilloscope or recorder. This output is in accordance with the selected mode, range, markers, etc.

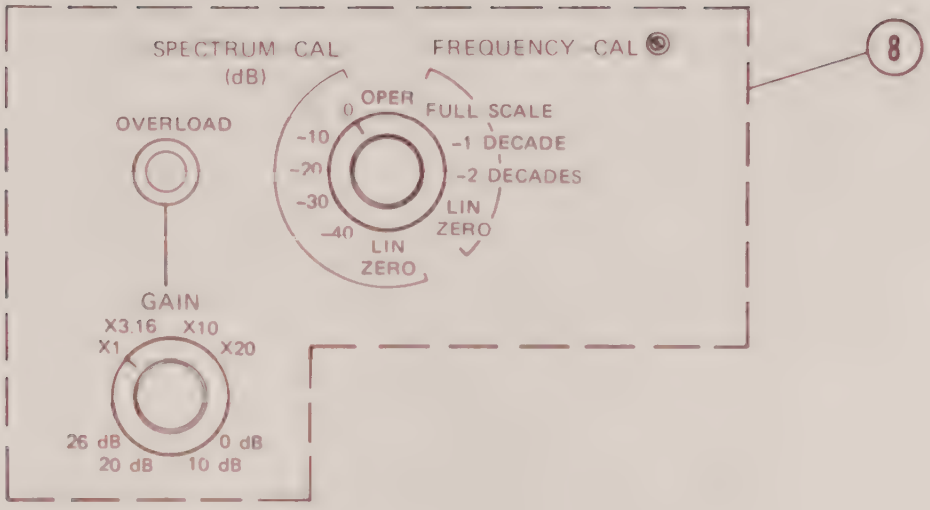
SPECTRUM CAL

In 0 dB position, an internally generated calibration signal equal in amplitude to the selected coarse input range is applied to the analyzer input circuit, thus providing a calibrated output spectrum.

The -10, -20, -30, and -40 dB positions provide accurately attenuated calibration levels referenced to the selected coarse input range. In LIN ZERO position, zero signal input is applied to provide a zero output reference point referenced to the selected coarse input range for overall "spectrum amplitude"-axis calibration. In SCOPE FAST and SLOW modes, the spectrum is continuously analyzed for display. In all other modes, the fundamental of the calibration signal is automatically tuned.

FREQUENCY CAL

In FULL SCALE position, a d-c output proportional to full-scale of the ANALYSIS RANGE is provided in both log and linear form. The -1 DECADE and -2 DECADES position provide 1/10 and 1/100 of full-scale output referenced to FULL SCALE position. LIN ZERO provides a zero reference point referenced to full-scale for overall frequency-axis calibration.



OVERLOAD Indicator

Lights to indicate that the signal output range is being exceeded; i.e., the linear output exceeds 5V. Note that although the INPUT OVERLOAD indicator may not be lighted for a particular input signal, the output spectrum peak could exceed 5V linear dc, lighting the OUTPUT OVERLOAD indicator. Therefore the INPUT RANGE would need to be attenuated.

GAIN Switch

Provides additional post-filter gain; X1 (unity or 0 dB), X3.16 (+10 dB), X10 (+20 dB) or X20 (+26 dB). Normally set to X1 for all periodic input signals. Additional gain can be inserted as required for a suitable output presentation when analyzing broadband signals such as white noise. Note that the frequency markers are attenuated in the X10 and X20 positions to prevent overloading.

Frequency Offset Control

This screwdriver-adjust control is located just to the right of the words "FREQUENCY-CAL"; it is used as follows:

> When using display oscilloscope, select 10 intensity markers with % FULL SCALE switch (described below) and internal FREQUENCY MARKERS; then adjust frequency offset control so intensity markers coincide with peaks of frequency marker.
>
> When using an X-Y recorder, select 0 dB SPECTRUM-CAL output mode (FREQUENCY MARKERS-OFF) and adjust frequency offset control for maximum SPECTRUM signal output.

(9) OUTPUT MODE Switch Group

MODE Switch

Selects the time base of the spectrum output display.

EXT AVGR (External Average)

The output averaged spectrum sweep rate is controlled from an external source such as the SD302. (The SD301C unaveraged spectrum output is at a 20-Hz rate regardless of the SD302 mode.)

SCOPE FAST (.05 SEC)

Output spectrum display is presented 20 times per second regardless of frequency range selected. Note that on low frequency ranges, many displays of the same spectrum may be outputed before the memory is completely updated.

SCOPE SLOW (.1 SEC)

Output spectrum display is presented 10 times per second, thus taking 100 ms to complete each display. At this rate, 1000 filter locations are synthesized allowing a "smoother" coverage of the spectrum.

PLOTTER

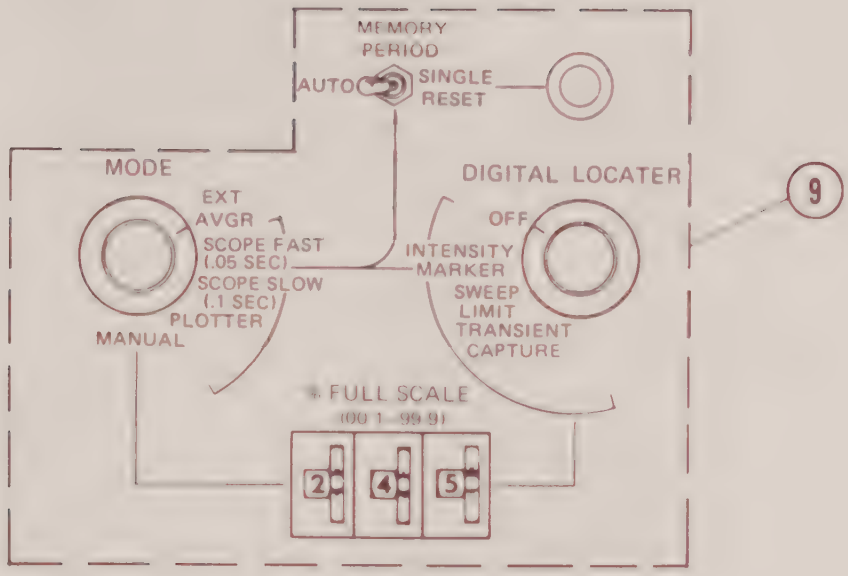
Assuming no input signal, basic output spectrum sweep times of 32, 64, or 320 seconds are available by connection of an internal jumper. In PLOTTER mode, a sweep rate feedback circuit is activated. With a signal input, the time for one complete sweep becomes a function of the change of signal amplitude. That is, the sweep is automatically slowed when a large amplitude variation occurs in the Y-axis.

MANUAL/% FULL SCALE (00.1–99.9)

Analyzer operates as a tuned filter; the filter center frequency is manually selected by the 3-digit thumbswitch, % FULL SCALE. (For other uses of the % FULL SCALE switch, refer to the DIGITAL LOCATER described below.)

Sweep Initiation Switch (AUTO–MEMORY PERIOD–SINGLE/RESET)

(Used with SCOPE FAST, SCOPE SLOW, or PLOTTER mode.)



AUTO

The swept spectrum output is continuously provided at selected mode and sweep rate.

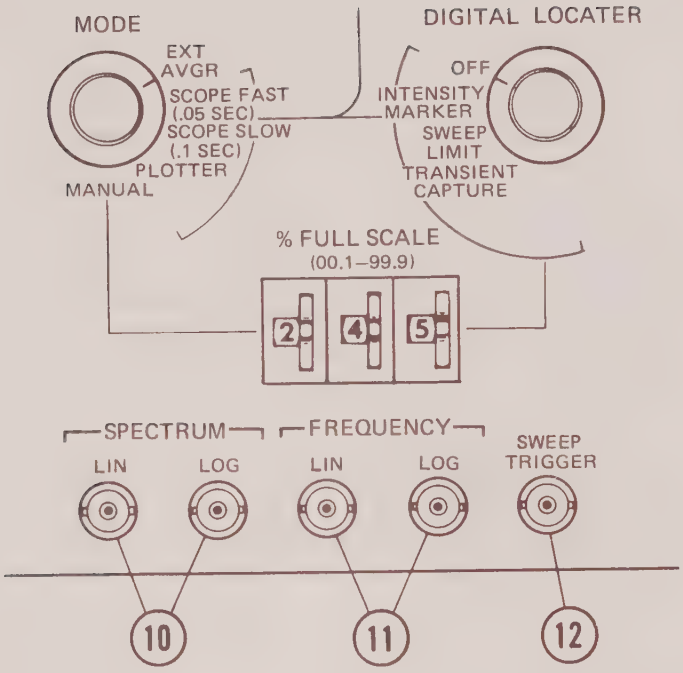
MEMORY PERIOD

A swept spectrum is provided only once each time the memory is loaded with new data, thus redundant spectrum outputs are eliminated. Therefore, in MEMORY HOLD mode, no new data is entered and the spectrum is not swept.

SINGLE/RESET Push Button/Indicator

Used only in SINGLE/RESET mode. If analyzer is reset, pressing button will initiate a single sweep; if analyzer is sweeping, pressing button will reset sweep. Indicator is lighted when analyzer is not reset. The SWEEP TRIG input, rear-chassis connector J20, accepts a 5V, 2 μs pulse to perform the function described above.

When in the plotter mode, a plot is started (from reset condition) by pressing the SINGLE RESET push button once; if pressed again during the sweep, the plotter will reset to the lower sweep limit and remain there until another sweep is initiated. When the sweep is completed, the pen will stop at full scale; the SINGLE RESET button must be pressed to reset the sweep.



DIGITAL LOCATER

Provides additional subfunctions, as marked, when operating in SCOPE FAST, SCOPE SLOW, and PLOTTER modes. For any of the following functions using the % FULL SCALE switch, a position marker is provided at rear-chassis connector J25. This marker indicates when value of % FULL SCALE is reached.

INTENSITY MARKER

Used in SCOPE FAST or SCOPE SLOW mode to provide an intensity marker on X-Y display oscilloscope. Position of marker is determined by value of % FULL SCALE switch (except for 000 setting which provides 10 equally-spaced intensity markers). Note that in the SCOPE FAST mode, the analysis steps are in 0.2% increments of full scale; therefore, the setting of the % FULL SCALE switch is rounded off to the 0.2% value.

SWEEP LIMIT

Sweep will be truncated at point selected by % FULL SCALE switch.

TRANSIENT CAPTURE

The number of samples to be loaded into memory during transient capture mode is determined by value of % FULL SCALE switch (250 to 999 samples). If the DIGITAL LOCATER is not set to TRANSIENT CAPTURE, the transient capture mode loads 1500 data points. Refer to Paragraph 2.8 in Section II for transient analysis mode of operation.

OFF

Switch should be set to OFF when none of the preceding functions are desired.

(10) *SPECTRUM Outputs

LIN

Provides 0V to 5V d-c output. (This is a smoothed version of the SPECTRUM LIN STEP output that is available at J1 on the rear chassis.)

LOG

Provides 0V to 1V d-c output proportional to the log of the LIN output described above.

(11) *FREQUENCY Outputs

LIN

Provides 0V to 5V d-c output. (This is a smoothed version of the FREQUENCY LIN STEP output that is available at J16 on the rear chassis.)

LOG

Provides 0V to 1V d-c output proportional to the log of the LIN output described above.

(12) *SWEEP TRIGGER

Provides a transition from 5V to 0V that is synchronized with the start of each sweep; transition is back to 5V at end of sweep. (Connected in parallel with SWEEP TRIG connector J20 on the rear chassis.)

*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

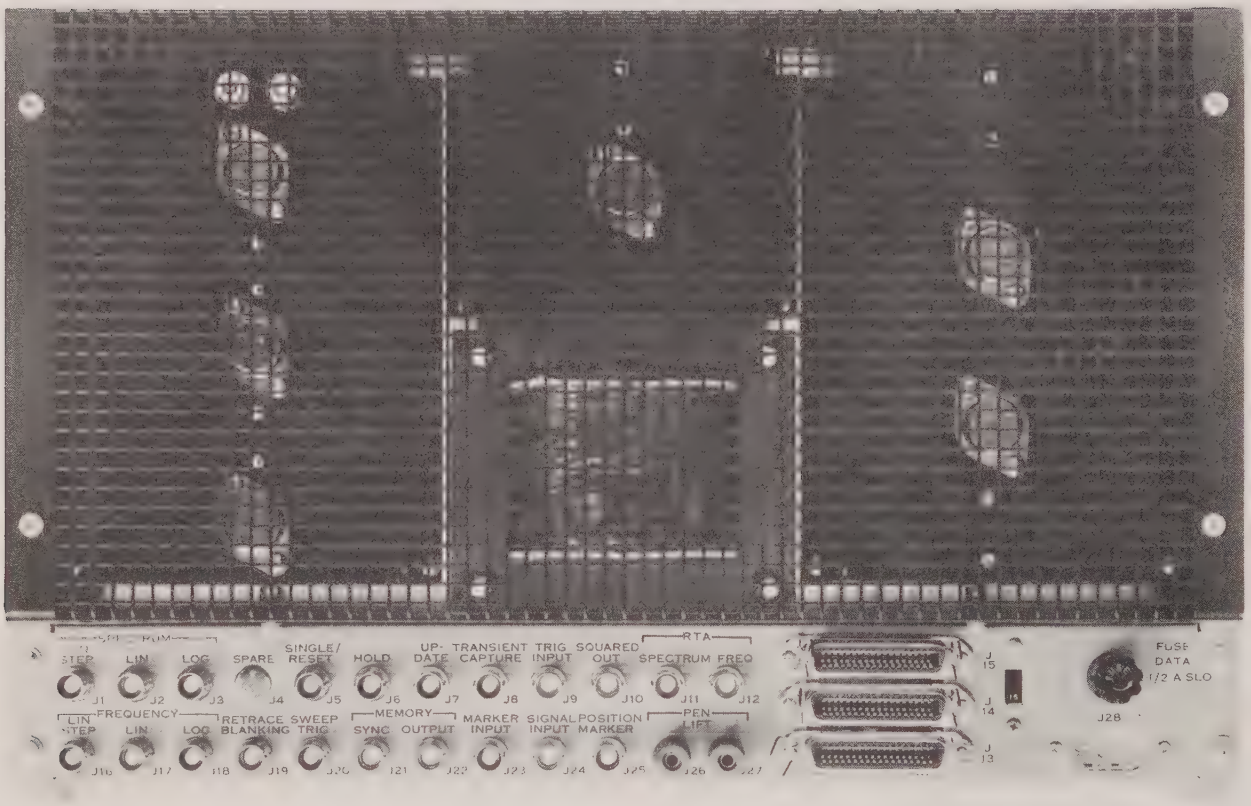


Figure 1-3. Rear Chassis

1.4 REAR CHASSIS FUNCTIONAL DESCRIPTION (See Figure 1-3.)

a. SPECTRUM OUTPUTS

*LIN STEP (J1)

The value of each step is proportional to the sampled spectrum signal amplitude of the synthesized filter location. The range is 0V to 5V.

*LIN (J2)

Provides 0V to 5V d-c output. (Connected in parallel with front-panel SPECTRUM LIN output connector.)

*LOG (J3)

Provides 0V to 1V d-c output proportional to the log of LIN output. (Connected in parallel with front-panel SPECTRUM LOG output connector.)

b. FREQUENCY Outputs

*LIN STEP (J16)

Provides 500 or 1000 incremental linear voltage steps from 0V to 5V; each step is proportional to the synthesized filter location.

*LIN (J17)

Provides 0V to 5V d-c output. (Connected in parallel with front-panel FREQUENCY LIN output connector.)

*LOG (J18)

Provides 0V to 1V d-c output proportional to the log of LIN OUTPUT. (Connected in parallel with front-panel FREQUENCY LOG output connector.)

c. SINGLE/RESET (J5)

Used only in SINGLE/RESET mode. Accepts external sweep trigger signal, nominally 5V at 2-microsecond duration. Application of pulse performs same action as pressing the front panel SINGLE/RESET push button.

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*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

d. HOLD (J6), UPDATE (J7), TRANSIENT CAPTURE (J8)

Application of a nominal 5V, 2-microsecond pulse to any of these inputs will automatically place the analyzer in the corresponding mode of operation.

e. TRIG INPUT (J9)

Used only when the front-panel TRANSIENT TRIGGER switch is set to EXT position; then application of a trigger signal will initiate loading in the transient capture mode. (Refer also to the front-panel description of TRIGGER LEVEL control.)

f. *SQUARED OUTPUT (J10)

Provides the squared value of the spectrum magnitude. Requires use of Output Amplifier Assembly No. 11430-3 (optional).

g. RTA SPECTRUM (J11)/FREQ (J12)

SPECTRUM (J11)

Normally provides RTA SPECTRUM LOG output (as described for J3). Jumper on circuit card A26 (see Figure 5-9) can be changed to provide LIN STEP or LIN output (as described for J1 or J2). This output is not affected when using external averager.

FREQ (J12)

Provides 500 incremental linear voltage steps from 0V to 5V; each step is proportional to the synthesized filter location.

h. *RETRACE BLANKING (J19)

Provides 0V during sweep, and 5V d-c level from end of sweep to beginning of the next sweep.

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*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

i. *SWEEP TRIG (J20)

Provides a transition from 5V to 0V that is synchronized with the start of each sweep; transition is back to 5V at end of sweep. (Connected in parallel with SWEEP TRIGGER connector on the front panel.)

j. MEMORY SYNC (J21)

Provides a 5V, approximately 2-microsecond pulse every time the memory recirculates.

k. MEMORY OUTPUT (J22)

Provides a speeded-up replica of the input signal that is stored in memory. This signal also contains the internal markers, if selected.

l. MARKER INPUT (J23)

Accepts external signals to be used as spectrum frequency-reference markers. Input impedance is 5k ohms nominal. A 1 Vrms input provides display markers at approximately 20 dB down from full scale. Connected in parallel with MARKER INPUT connector on front panel.

m. SIGNAL INPUT (J24)

Accepts signal to be analyzed; is connected in parallel with front-panel SIGNAL INPUT connector; is affected by setting of AC/DC switch. (Refer to front-panel description for SIGNAL INPUT connector, AC/DC switch.)

n. POSITION MARKER (J25)

Provides a % FULL SCALE position marker approximately +4V; duration varies according to mode selected. For examples, in SCOPE FAST mode with DIGITAL LOCATER set to OFF, position marker is approximately 100 microseconds duration; with DIGITAL LOCATER set to INTENSITY MARKER, approximately 500 microseconds duration. In PLOTTER mode, position marker stays high for time allotted to displaying the particular filter location.

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*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

o. *PEN LIFT (J26, J27)

Provides a normally-open set of contacts. During a plotter sweep the contacts are closed and are then automatically opened at end of sweep. Circuit is isolated from ground. Before using, observe CAUTION of Paragraph 2.4 in Section II of this manual.

p. J13

Auxiliary functions connector for interconnecting SD301C to a Model SD302 Ensemble Averager. Refer to Table 2-1 in Section II for pin functions.

q. J14

Auxiliary functions connector for interconnecting SD301C to a Model SD304 Signature Ratio® Adapter. Refer to Table 2-2 in Section II for pin functions.

r. J15

Auxiliary functions connector for interconnecting SD301C to a Model SD303 Spectrum Translator. Refer to Table 2-3 in Section II for pin functions.

s. 115/230 Switch

Facilitates changeover of primary power input circuit for either 115V or 230V operation. Proper input voltage to be applied shows in window; screwdriver blade slot is up for 115V operation and down for 230V operation.

t. FUSE

Contains 3AG type, 2-½A, SLO-BLO fuse.

u. POWER IN (J28)

Accepts 3-wire plug and cable (supplied) for applying 115/230 Vac 50—400 Hz primary input power. Center terminal is chassis ground. Uses Belden No. 17258-S cable.

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*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

1.5 SPECIFICATIONS

Upper Frequency Limit	3 dB BW (Hz)	Memory Period (second)
50,000 Hz	150	0.01
20,000 Hz	60	0.025
10,000 Hz	30	0.05
5,000 Hz	15	0.1
2,000 Hz	6	0.25
1,000 Hz	3	0.5
500 Hz	1.5	1.0
100 Hz	0.3	5.0
50 Hz	0.15	10.0
10 Hz	0.03	50.0

Sensitivity . . . . . (for full scale output)
0.1 Vrms to 28.2 Vrms, adjustable in 1 dB steps

Level Indication . . . . . Five digitally driven indicator lamps provide correct indication input level regardless of waveform.

Impedance . . . . . 100k ohm

Coupling . . . . . Selectable DC/AC (0.4 Hz Lower 3 dB point)

DYNAMIC RANGE . . . . . (full scale to minimum discernible signal) 50 dB

NOISE LEVEL . . . . . Average level 54 dB down from full scale with zero input signal

FREQUENCY MARKERS . . . . . 10 equally spaced markers — or external input

MODES OF OPERATION . . . . . (May be selected manually or remotely)

Update . . . . . Memory continuously updates with new data

Hold . . . . . Last data in memory is continuously recycled — no new information is added.

Transient Capture . . . . . With DIGITAL LOCATER set to TRANSIENT CAPTURE, % FULL SCALE switch setting determines number of data points to be loaded into memory; otherwise, 1500 data points are loaded. Triggering of transient capture mode (start of load cycle) may be done either externally with a pulse input or from the data itself. The d-c coupled triggering level is adjustable (for internal or external operation) from -5 dB to -35 dB.

EXTERNAL CONTROL OF OPERATIONAL MODE

Application of an external d-c level shift (nominally 5V – 2 μs minimum duration) to either the Update, Hold or Transient Capture input will automatically cause the selected mode to be activated.

INTERNAL CALIBRATION . . . . . Calibrates entire analyzer from signal input to d-c outputs.

Spectrum Axis . . . . . (LIN) – Full scale and zero

(LOG) – Full Scale, -10 dB, -20 dB, -30 dB, -40 dB

Frequency Axis . . . . . (LIN) – Full scale and zero

(LOG) – Full scale, -1 decade, -2 decades

SWEEP SPEED . . . . . Oscilloscope fast – a new sweep is initiated every 50 ms giving a "flicker free" oscilloscope display.

Oscilloscope slow – a new sweep is initiated every 0.1s by stepping the synthesized filter in 1/2 normal steps.

Plotter – a plot is completed in 32, 64, or 320 seconds as determined by an internal jumper; automatically controlled by SRF.

Manual – sweep position is controlled by % FULL SCALE switch.

External Averager – displayed sweep rate is placed under control of SD302, either Scope Fast or Plotter as selected on the SD302.

SWEEP INITIATION . . . . . Automatic – spectra are presented repeatedly, one after another.

External/Manual – a complete spectrum is swept each time a trigger pulse is provided or each time the sweep trigger button is depressed.

Memory Period – a sweep is initiated each time a memory load cycle is completed. Each spectrum display is statistically independent of the previous display.

DIGITAL LOCATER	Provides subfunctions of Scope Fast, Scope Slow, and Plotter modes; provides intensity markers, sweep limit, and transient capture, all controlled by % FULL SCALE switch.
POSITION MARKER	Provides a marker pulse output independently controlled by % FULL SCALE switch.
*OUTPUTS	
Spectrum Axis	Lin step – 0 to 5V detector output; one step for each synthesized filter location
	Lin – 0 to 5V (nominal) smoothed output of detector
	Log – 1V log smoothed output of detector
Frequency Axis	Lin step – 0 to 5V stepped ramp
	Lin – 0 to 5V (nominal) smooth ramp
	Log – 1V smooth log ramp
	Sweep Trigger – provides a transition from 5V to 0V that is synchronized with start of each sweep; transition is back to 5V at end of sweep
	Pen Lift – an isolated relay contact closure when sweeping in plotter mode
	Retrace Blanking – provides 0V during sweep, and 5V d-c level from end of sweep to beginning of next sweep
MEMORY CONTENTS	500 mV p-p full scale signal displaying the speeded up signal stored in memory
FREQUENCY RESPONSE	±1 dB over entire frequency range
LINEARITY OF SPECTRUM OUTPUT	±0.5% of full scale or ±1 dB, whichever is greater

*In EXT AVGR mode, these outputs are those of the external averager being used (normally a Model SD302C Ensemble Averager).

SEPARATION	Two equal amplitude sinusoids, spaced 2 filter bandwidths apart, when applied simultaneously to the SD301C will exhibit an average 6 dB valley between the spectral peaks
SELECTIVITY	Filter response is at least −20 dB at a frequency removed from center frequency by 2 bandwidths and −40 dB at 4.5 bandwidths, ±15%.
FREQUENCY LINEARITY	±0.2% of best straight line of full analysis range; offset is adjustable with built-in test feature so best straight line matches calibration points.
POWER	105–125/210–250 Vac (switch-selectable); 50 to 400 Hz; ≈175W; (≈195W for SD301C/SD302 combination)
DIMENSIONS	Height . . . . . 10-1/2" (26,6 cm) Width . . . . . 19" (48,3 cm) Depth . . . . . 21" (53,3 cm) Shipping Weight . . . . . 60 lbs (27,2 kg)

SECTION II

OPERATION

2.1 GENERAL

The Model SD301C Real Time Analyzer provides a display output proportional to the magnitudes of the Fourier components. For display purposes, an oscilloscope, an X-Y recorder, or other readout device must be used for presenting the output. The following paragraphs provide basic setup and calibration procedures for calibrating a display and recording device to the outputs of the SD301C.

Before operating the instrument, it is recommended that the operator study carefully the front-panel and rear-chassis functional descriptions given in Paragraphs 1.3 and 1.4 in Section 1 of this manual. Note that all front-panel connectors are wired in parallel with similarly marked connectors on the rear chassis.

2.2 INITIAL POWERING PROCEDURE

a. Check that the 115/230 switch on the instrument rear chassis is set according to the input line voltage and that a fuse with the correct rating is installed.

b. Connect power cord to primary power source.

c. Press the POWER switch/indicator; it should light to indicate power is applied to all internal circuits.

2.3 OPERATIONAL CHECKOUT PROCEDURE

This procedure provides a complete operational checkout of the Model SD301C. Provisions have been included to also check a Model SD302 (series) Ensemble Averager, if used, with the Model SD301C.

a. Apply power to the SD301C as described in Paragraph 2.2.

b. On the SD301C, set the front-panel controls as follows:

INPUT RANGE (Vrms) coarse switch to .316, fine switch to 0/CAL
AC/DC switch to AC
FREQUENCY MARKERS switch to OFF
TRANSIENT TRIGGER switch to INT
MEMORY in UPDATE mode (Press UPDATE push button if necessary.)
ANALYSIS RANGE switch to 5K
OPER/CAL switch to SPECTRUM-CAL, 0 dB
GAIN switch to X1 (0 dB)
MODE to SCOPE FAST
Sweep Initiation switch to AUTO
DIGITAL LOCATER to OFF
% FULL SCALE switch to 000

If a Model SD302 is connected to the Model SD301C, set the controls on the SD302 as follows:

NO. OF ENSEMBLES switch to 1
DISPLAY CONTROL switch to SCOPE
AVERAGING STOP indicator lighted (Press if necessary.)
PLOTTER SWEEP RATE SLOW/NORMAL (rear chassis) to NORMAL

c. Connect SPECTRUM LOG OUTPUT to display oscilloscope vertical input (200 mV/division sensitivity); connect FREQUENCY LIN OUTPUT to horizontal input (approximately 500 mV/division sensitivity). Ensure oscilloscope is d-c coupled; if necessary, refer to Paragraph 2.4 for further details.

Adjust oscilloscope so peak spectrum line is on a graticule line. See Figure 2-1a. Observe that 3rd harmonic is approximately 1 division below (-9.5 dB) the fundamental peak; if not, adjust scope vertical sensitivity for an indication of 10 dB per division.

Fundamental should be at 30% of full-scale frequency.

The base line as shown in Figure 2-1a is adjusted to provide 54 dB dynamic range. The base line can be moved up or down as desired by adjusting BASE LINE CLIPPER ADJUST A21R48 accessible through a hole in the top cover.

d. Set GAIN switch to X3.16 (10 dB); OUTPUT OVERLOAD indicator should light. Return GAIN switch to X1 (0 dB).

e. Set MODE switch to MANUAL; intensity marker should be near the same vertical graticule line as the fundamental. (See Figure 2-1b.) Adjust Frequency Offset potentiometer (next to "FREQUENCY-CAL") to ensure intensity marker is at peak amplitude.

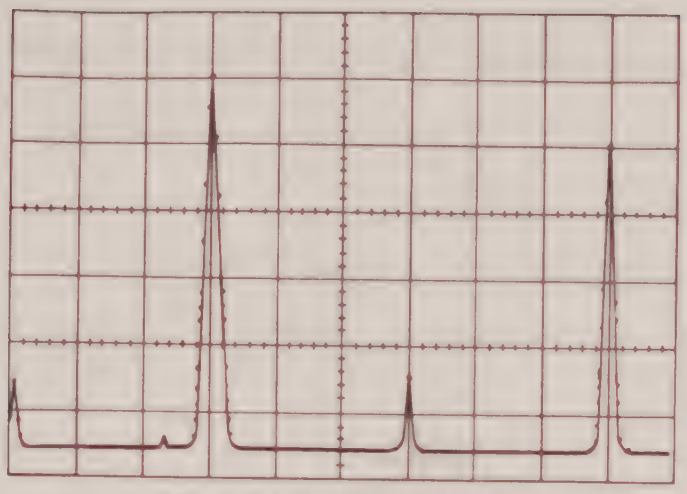


Figure 2-1a. Calibration Signal

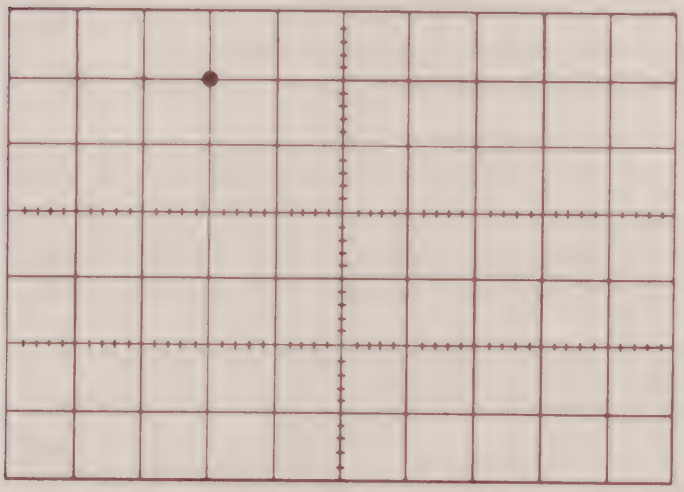


Figure 2-1b. Intensity Marker at Peak of Calibration Signal Fundamental, MANUAL MODE

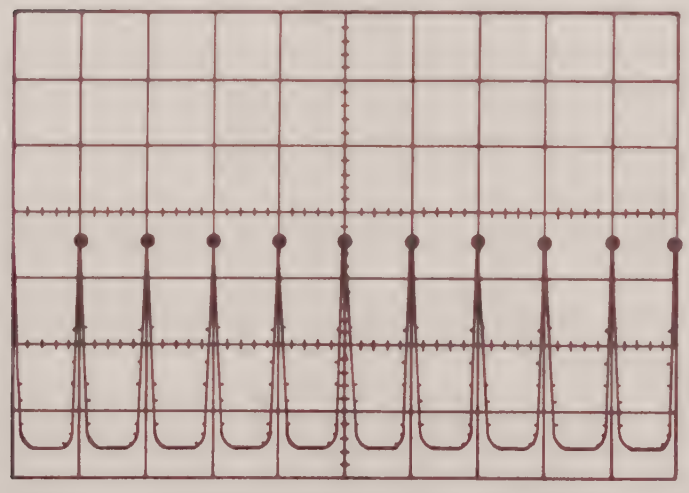


Figure 2-1c. Frequency Markers with 10 Intensity Markers

f. On SD301C, set switches as follows:

MODE to SCOPE FAST
OPER/CAL to OPER
FREQUENCY MARKERS to INT
DIGITAL LOCATER to INTENSITY MARKER

Observe 10 intensity markers, one on top of each frequency marker. (See Figure 2-1c.) If presentation is not correct, recalibrate the VCO in accordance with the procedure of Paragraph 4.2.7.

g. On SD301C, set switches as follows:

FREQUENCY MARKERS to OFF
OPER/CAL to SPECTRUM-CAL, 0 dB
ANALYSIS RANGE to 10 (Hz)

After approximately 50 seconds, the display should return to that shown in Figure 2-1a (except that 10 intensity markers are present). Select each ANALYSIS RANGE up to 50K; for each setting, wait the indicated MEMORY PERIOD (SEC); and verify that display is as shown in Figure 2-1a.

h. Check output linearity as follows:

1) Set OPER/CAL switch to SPECTRUM-CAL −10; verify a 10 dB decrease in output (1 division down on oscilloscope).

2) Set GAIN switch to X3.16 (10 dB); verify a 10 dB increase in output.

3) Set OPER/CAL to −20 dB; verify a 10 dB decrease in output.

4) Set GAIN to X10; verify a 10 dB increase in output.

5) Set OPER/CAL to −30 dB; verify a 10 dB decrease in output.

6) Set GAIN to X20; verify a 6 dB increase in output (0.6 division on oscilloscope).

7) Set GAIN to X1; verify a 26 dB decrease from X20 setting of step 6).

8) Set OPER/CAL to -40 dB; verify a 10 dB decrease in output.

9) Set OPER/CAL to LIN ZERO; verify zero output.

10) Return OPER/CAL switch to SPECTRUM-CAL 0 dB.

i. Check fine INPUT RANGE attenuator operation: verify a 1 dB (0.1 division on oscilloscope) change for each setting, 1, 2, 3, 4, 5, 6, 7, 8, 9. Return fine attenuator to 0/CAL.

j. Set FREQUENCY MARKERS switch to INT. Press and hold in the MEMORY HOLD push button while setting OPER/CAL switch to OPER; then release MEMORY HOLD push button; indicator should remain lighted. (The calibration signal and frequency markers are now held in memory.)

k. Check operation of Sweep Initiation functions as follows:

1) Set MODE switch to SCOPE SLOW. Note increased flicker on output display.

2) Set MODE switch to PLOTTER and Sweep Initiation to MEMORY PERIOD; SINGLE/RESET will light and stay lit.

3) Place Sweep Initiation switch to SINGLE/RESET; button will light and sweep trace will start moving across the oscilloscope.

4) Press SINGLE/RESET push button; indicator goes out and sweep trace resets to extreme left and stays.

5) Press SINGLE/RESET again; indicator lights and sweep slowly scans outline of calibration signal and frequency markers.

l. Set MODE switch to MANUAL; sweep trace will reset to the left. Rotate the % FULL SCALE switch to 10.0, 20.0, and 30.0; the intensity marker will appear at the top of the first frequency marker, the second marker, and then the calibration signal, in that order.

m. Check the operation of the DIGITAL LOCATER, SWEEP LIMIT mode:

1) Set MODE switch to SCOPE FAST, Sweep Initiation switch to AUTO, DIGITAL LOCATER to SWEEP LIMIT, and % FULL SCALE to 30.0. Observe that only 30 percent of sweep is present on display oscilloscope.

2) Change % FULL SCALE in increments of 01.0 from 31.0 to 39.0. For each setting, verify that sweep length increases proportionally in 1 percent increments.

3) Change % FULL SCALE in increments of 00.1 between 30.0 and 30.9. Verify sweep length increases proportionally only for even number settings (30.2, 30.4, etc.).

Set DIGITAL LOCATER to OFF, and % FULL SCALE to 000.

NOTE

If a Model SD302 is also being checked out, proceed with the following Step *n. (The steps preceded with an asterisk are applicable to the SD302 only.)

If an SD302 is not used, proceed to Step r. for the remaining SD301C checks.

*n. Check the averaging operation of the SD302 as follows:

1) On SD302, check that the NO. OF ENSEMBLES switch is set to 1, the DISPLAY CONTROL switch is set to SCOPE, and the AVERAGING STOP push button is lighted.

2) On SD301C, set the MODE switch to EXT AVGR.

3) On SD302, press the AVERAGING START push button. Push button will light and output display will be one average (full scale) of calibration frequency and frequency markers.

4) On SD302, set NO. OF ENSEMBLES switch to 2. Output display will decrease by 6 dB. Press START push button and observe 2 averages built up to full scale.

5) Repeat step 4) for 4, 8, 16 and 32 NO. OF ENSEMBLES (or more if desired). In each case, after the START push button is pressed, the spectrum average display will be seen to build up until the end of the averaging cycle produces a full-scale presentation. Also at the end of each averaging cycle, the STOP indicator will light.

*o. Set NO. OF ENSEMBLES switch to 1 and press AVERAGING START push button to average one ensemble (full-scale presentation on oscilloscope). Step the NO. OF ENSEMBLES switch to 2, 4, 8, 16, etc. up to 1024; observe that output decreases in increments of 6 dB for each step increase of the NO. OF ENSEMBLES switch.

*p. Check SD302 PLOTTER mode as follows:

1) Set DISPLAY CONTROL to PLOTTER. Observe that sweep trace resets to the left, and PLOTTER RESET and HOLD push buttons light.

NOTE

Read all of the following step 2) before pressing the PLOTTER SWEEP push button. Be prepared to press the HOLD push button.

2) Press the PLOTTER SWEEP push button. Observe sweep trace starts to scan the calibration signal and frequency markers on the oscilloscope. (If SLOW/NORMAL switch on SD302 rear chassis is set to SLOW, the first 64 synthesized filter locations will be scanned slowly; then the sweep speed will increase to normal.) At some time during the sweep (near the center perhaps), press the HOLD push button. The HOLD indicator will light and the sweep trace will stop.

3) Press the SWEEP push button; the HOLD indicator will go out, SWEEP will light, and the sweep trace will resume sweeping from stopping point of step 2) above. Upon completion of sweep, the sweep trace will reset to the left and the RESET and HOLD indicators will light.

*q. On the SD302, set DISPLAY CONTROL to COMPUTER DIRECT. The RESET and HOLD indicators will go out, and a digitally converted replica of the calibration signal and frequency markers will be presented on the display oscilloscope.

On SD301C, set MODE switch to SCOPE FAST in readiness for next check.

r. Checkout SD301C TRANSIENT CAPTURE mode as follows:

1) Set FREQUENCY MARKERS switch to OFF, and ANALYSIS RANGE to 5K.

2) Press the MEMORY TRANSIENT CAPTURE push button. It will light.

3) Rotate TRIGGER LEVEL control to -35 dB; TRANSIENT CAPTURE indicator should stay lit. (This verifies that the TRANSIENT CAPTURE mode can not be triggered by noise.)

4) Adjust TRIGGER LEVEL to approximate mid-point between -35 dB and -5 dB. (Note that this is not mid-range; the adjustment is not a linear function.)

NOTE

In the following steps, the 60-Hz square wave signal is only touched to the SIGNAL INPUT connector center terminal and immediately removed.

5) Momentarily apply a 60-Hz square wave signal, approximately 0.5V p-p to the SIGNAL INPUT and observe transient capture as indicated by the action of the following indicators: TRANSIENT CAPTURE goes out, UPDATE momentarily lights and goes out, and then HOLD lights.

Observe the Fourier analysis of the 60-Hz square wave (captured and now held in memory).

6) Set DIGITAL LOCATER to TRANSIENT CAPTURE (% FULL SCALE is at 000), and press TRANSIENT CAPTURE push button.

7) Again apply the 60-Hz square wave signal; HOLD indicator will flash but no display will be presented on the oscilloscope. Hold indicator lights

8) Set % FULL SCALE switch to 200 and press the TRANSIENT CAPTURE push button.

9) Again apply the 60-Hz signal and observe transient capture as previously described in step 5) above. [Note the number (1 to 999) set into the % FULL SCALE switch denotes the number (1 to 999) of data points loaded into memory during the transient capture; therefore, the oscilloscope display may vary between settings.] If desired, repeat steps 8) and 9) for various settings (400, 600, 800, etc.) of the % FULL SCALE switch.

This completes the operational checkout procedure.

2.4 SETUP INSTRUCTIONS FOR USING OSCILLOSCOPE OR X-Y RECORDER

CAUTION

To prevent permanent damage to the pen lift relay contacts in the SD301C, be sure that a diode is installed across the pen lift solenoid coil in the recorder being used.

Unless otherwise indicated for each of the following calibration procedures, set the SD301C front-panel controls as follows:

INPUT RANGE (Vrms) coarse switch to 1, fine switch to 0/CAL
FREQUENCY MARKERS switch to OFF
MEMORY UPDATE switch/indicator is lighted
ANALYSIS RANGE switch to 10K
GAIN to X1
OPER/CAL switch to OPER
MODE switch to SCOPE FAST
Sweep Initiation switch to AUTO
DIGITAL LOCATER to OFF

2.4.1 Oscilloscope Setup

The oscilloscope horizontal and vertical axes may be calibrated using any desired combination of FREQUENCY (horizontal) versus SPECTRUM (vertical) outputs; i.e., LIN/LIN, LIN/LOG, LOG/LOG, etc.

The oscilloscope to be used must be d-c coupled and have a bandwidth of 100 kHz or more; the sensitivity must be 100 mV/cm or better. The following procedures assume an oscilloscope graticule that is linearly incremented; 10 horizontal and 8 or more vertical divisions.

a. Connect the desired FREQUENCY (LOG or LIN) output to the oscilloscope horizontal input.

b. Connect the desired SPECTRUM (LOG or LIN) output to the oscilloscope vertical input.

c. On SD301C, set FREQUENCY MARKERS switch to INT, DIGITAL LOCATER to INTENSITY MARKER, and % FULL SCALE to 000.

d. Adjust Frequency Offset control (accessible next to "FREQUENCY CAL") so that the intensity markers coincide with the tops of the frequency markers.

e. Adjust the oscilloscope horizontal gain and zero controls for the desired presentation; i.e., for FREQUENCY LIN, adjust the oscilloscope so that the 10 markers coincide with 10 vertical graticule lines. For FREQUENCY LOG, the ten markers will indicate the top decade of the frequency range.

f. On SD301C, set the FREQUENCY MARKERS switch to OFF; set the OPER/CAL switch to SPECTRUM-CAL 0 dB.

For a LIN presentation, adjust oscilloscope vertical gain and zero controls for desired display.

For a LOG presentation, adjust oscilloscope vertical gain and zero controls using the SPECTRUM-CAL switch position (0 dB, -10 dB, -20 dB, etc.) as required by the expected signal amplitude dynamics.

2.4.2 X-Y Recorder Setup

The X-Y recorder X-axis and Y-axis may be calibrated using any desired combination of FREQUENCY (X-axis) versus SPECTRUM (Y-axis) outputs; i.e., LIN/LIN, LIN/LOG, LOG/LOG, etc. The following procedures describe each type of output and associated recorder axis calibration. The operator may combine them as desired.

Set MODE switch to PLOTTER during X-Y recorder calibration.

2.4.2.1 FREQUENCY LIN (X-Axis)

a. Connect FREQUENCY LIN output to the recorder X-axis input.

b. On SD301C, set the OPER/CAL switch to FREQUENCY CAL, LIN ZERO.

c. Adjust recorder X-axis zero control to position pen over desired left-hand margin line.

d. Set SD301C OPER/CAL switch to FREQUENCY CAL, FULL SCALE.

e. Adjust recorder X-axis variable gain control to position pen over desired right-hand margin line.

f. Repeat Steps b. through e. to check for any interaction.

2.4.2.2 FREQUENCY LOG (X-Axis)

a. Connect FREQUENCY LOG output to recorder X-axis input.

b. Set SD301C OPER/CAL switch to FREQUENCY CAL, 2 DECADES (or -1 DECADE for 1-decade presentation).

c. Adjust recorder X-axis zero control to position pen over desired left-hand line, representing -2 decades (or -1 decade) below full scale.

d. Set SD301C OPER/CAL switch to FREQUENCY CAL, FULL SCALE.

e. Adjust recorder X-axis variable gain control to position pen over desired right-hand margin line.

f. Repeat Steps b. through e. to check for any interaction.

2.4.2.3 SPECTRUM LIN (Y-Axis)

a. Connect SPECTRUM LIN output to recorder Y-axis input.

b. On SD301C, set OPER/CAL switch to SPECTRUM-CAL LIN ZERO. Set FREQUENCY MARKERS switch to OFF.

c. Adjust recorder Y-axis zero control to position pen over the desired lower horizontal graph line.

d. On SD301C, set OPER/CAL switch to SPECTRUM-CAL, 0 dB.

e. If necessary, adjust the Frequency Offset control (accessible next to "FREQUENCY-CAL") for maximum.

f. Adjust recorder Y-axis variable gain control to position pen over desired upper horizontal graph line.

g. Repeat Steps b. through f. to check for any interaction.

2.4.2.4 SPECTRUM LOG (Y-Axis)

a. Connect SPECTRUM LOG output to the recorder Y-axis input.

b. On SD301C, set OPER/CAL switch to position (–10 dB, –20 dB, etc.) as required by the expected signal amplitude dynamics.

c. If necessary, adjust the Frequency Offset control (accessible next to "FREQUENCY-CAL") for maximum.

d. Adjust recorder Y-axis zero control to position pen over the desired lower horizontal graph line.

e. On SD301C, set OPER/CAL switch to SPECTRUM-CAL, 0 dB.

f. Adjust recorder Y-axis variable gain control to position pen over desired upper horizontal graph line.

g. Repeat Steps b. through f. to check for any interaction.

2.5 CONNECTOR FUNCTIONS

Tables 2-1, 2-2, and 2-3 provide the input/output functions for each pin of rear-chassis connectors J13, J14, and J15.

Table 2-1. J13 Connector Functions

Pin No.	Function
1	External sample sync from A17-17
2	External Sweep start from A17-13
3	SD302 Plotter to A16-C
4	SD302 Sweep to A16-J
5	Sampled Spectrum signal from A29-17
6	SD302 Frequency axis signal to A21-13
7	10 kHz, 20 kHz, or 50 kHz Range selected
8	Select 5 kHz Range from S1A
9	Averaged spectrum signal to A21-6
10	Select 2 kHz Range from S1A
11	Select 500 Hz Range from S1A
12	Select 100 Hz Range from S1A
13	Select 50 Hz Range from S1A
14	+12V
15	–12V
16	+28V
17	+5V
18	Select 10 Hz Range from S1A
19–25	Ground
26–35	Spare
36	Select 1 kHz Range from S1A

Table 2-2. J14 Connector Functions

Pin No.	Function
1	Ground
2	Ground to enable external Range control at A2-22
3	Select 10 Hz Range from S1A
4	Select 100 Hz Range from S1A
5	Select 2 kHz Range from S1A
6	Select 10 kHz Range from S1A
7	10 kHz, 20 kHz, or 50 kHz Range selected
8–12	Spare
13	Select 50 kHz Range from S1A
14–17	Spare
18	Remote Freq Offset to A25-14
19	Ground
20	External Sample input to A2-K
21	Select 50 Hz Range from S1A
22	Select 500 Hz Range from S1A
23	Select 5 kHz Range from S1A
24	Select 20 kHz Range from S1A
25–35	Spare
36	Select 1 kHz Range from S1A

Table 2-3. J15 Connector Functions

Pin No.	Function
1	*Word sync output from A30-7
2	Select 20 kHz Range from S1A
3	*Bit 1 (MSB) output from A30-20
4	*Bit 2 output from A30-19
5	*Bit 3 output from A30-8
6	*Bit 4 output from A30-9
7	Select 10 kHz Range from S1A
8	Select 5 kHz Range from S1A
9	*Bit 5 output from A30-10
10	Select 2 kHz Range from S1A
11	*Bit 6 output from A30-11
12	*Bit 7 output from A30-12
13	Select 50 kHz Range from S1A
14	*Bit 8 output from A30-13
15	*Bit 9 output from A30-18
16	*Bit 10 (LSB) output from A30-14
17	*Frame sync output from A30-2
18	Remote Freq Offset to A25-14
19	Spare
20	Ground
21–35	Spare
36	Select 1 kHz Range from S1A
	*Available only with "-12" modification, Output A-D Converter Assembly 14846-1 installed in receptacle XA30.

2.6 ANALYSIS OF A PERIODIC SIGNAL

This procedure is designed to guide the operator through a typical operational program using an oscilloscope and an X-Y recorder. Assume for this example that a data signal is being generated from an accelerometer attached to a running test specimen. Also, the output of the accelerometer and conditioning amplifier has been normalized to an output sensitivity of 10 mV rms/g rms.

a. Apply power to the SD301C, oscilloscope, and X-Y recorder. (Refer to Paragraph 2.2 for powering procedure, if necessary.)

b. Connect SPECTRUM LOG output to oscilloscope and recorder Y-axis inputs; connect FREQUENCY LIN output to oscilloscope and recorder X-axis inputs.

NOTES

1) Verify that the SD301C FREQUENCY OUTPUT (X-Axis) is properly calibrated. Refer to Paragraph 2.3, Steps e. and f.

2) Linear graph paper with 7-by-10 major divisions is recommended.

c. Adjust the oscilloscope and recorder gain and zero controls as described in Paragraph 2.3. Calibrate the Y-axis so that each major division change between horizontal graticule lines represents a 10 dB change in output.

d. Set the SD301C front-panel controls as follows:

INPUT RANGE (Vrms) coarse switch to 1
Fine RANGE switch to 0/CAL
FREQUENCY MARKERS switch to OFF
ANALYSIS RANGE switch to 10K
Press MEMORY UPDATE mode push button
GAIN switch to X1
OPER/CAL switch to OPER
MODE switch to SCOPE FAST
Sweep Initiation switch to AUTO
DIGITAL LOCATER to OFF

e. Apply the data signal to the SD301C SIGNAL INPUT connector and adjust the INPUT RANGE (Vrms) switches for a NORMAL input level indication; this condition allows optimum use of the instruments dynamic range.

Assume for this example that the coarse INPUT RANGE switch is set to .316 Vrms and the fine switch to 4 dB.

f. Set the OPER/CAL switch to SPECTRUM-CAL 0 dB.

NOTE

The 0 dB calibration level is equivalent to a full-scale input level of 31.6g rms or 44.68g peak, based on a signal sensitivity of 10 Vrms/g rms.

g. Adjust the oscilloscope position control so that the peak of the display is at full scale.

h. Set the MODE switch to PLOTTER, and energize the servos on the X-Y recorder.

i. Calibrate the recorder Y-axis for full-scale indication (use the ZERO control and position the pen over the full-scale horizontal line); then place the recorder in standby mode.

CAUTION

Both the INPUT RANGE fine attenuator and post filter GAIN switches are in the calibration signal "path", and, therefore affect the

(Cont'd)

CAUTION (Cont'd)

output signal level. If they cannot be preset using the actual data signal, any change of settings required after calibration must be compensated for by a corresponding change in dB on the recorder graph.

j. On the SD301C, set MODE switch to SCOPE FAST and OPER/CAL to OPER. The display oscilloscope will now present the Fourier analysis of the data input signal to 10 kHz.

k. Press the MEMORY HOLD push button.

l. Set MODE switch to PLOTTER, Sweep Initiation switch to SINGLE/RESET, and press the SINGLE/RESET push button. The oscilloscope trace will reset to the left; the SINGLE/RESET indicator will not be lighted.

m. Energize the X-Y recorder servos and pen-down. (If automatic pen lift is connected to the SD301C, pen-down is automatically activated.)

n. Press the SINGLE/RESET push button. The X-Y recorder will produce a record in the time as internally set and as affected by sweep rate feedback.

At the end of the record, place the X-Y recorder in standby mode.

o. On SD301C, set MODE switch to SCOPE FAST, Sweep Initiation to AUTO, and press the MEMORY UPDATE push button. The analyzer will now accept new data for subsequent displaying and recording.

2.7 ANALYSIS OF ACOUSTIC DATA

This procedure is designed to guide the operator through a typical operational program using an oscilloscope and an X-Y recorder. For this example, acoustic analysis in the form of sound pressure level and normalized spectrum level is illustrated. The relationship between normalized spectrum level and sound pressure level is given by:

$$S = L - 10 \log_{10} \Delta f \text{ dB}$$

Where S = Spectrum level in dB
L = Sound pressure level in dB
Δf = Analyzer filter bandwidth

For the following example, assume that an on-line analysis is being performed and that a Sound Level Calibrator is available that has an output of 114 dB at 1 kHz. The output level of the signal conditioning equipment is 300 mV rms with the calibration signal applied.

a. Apply power to the SD301C, oscilloscope, and X-Y recorder. (Refer to Paragraph 2.2 for powering procedure, if necessary.)

b. Connect SPECTRUM LOG output to oscilloscope and recorder Y-axis inputs; connect FREQUENCY LIN output to oscilloscope and recorder X-axis inputs.

NOTES

1) Verify that the SD301C FREQUENCY OUTPUT (X-axis) is properly calibrated. Refer to Paragraph 2.3, Steps e. and f.

2) Linear graph paper with 7-by-10 major divisions is recommended.

c. Adjust the oscilloscope and recorder gain and zero controls as described in Paragraph 2.3. Calibrate the Y-axis so that each major division change between horizontal graticule lines represents a 10-dB change in output.

d. Set the SD301C front-panel controls as follows:

INPUT RANGE (Vrms) coarse switch to .316
Fine RANGE switch to 0/CAL
FREQUENCY MARKERS switch to OFF
ANALYSIS RANGE switch to 10K
Press MEMORY UPDATE mode push button
GAIN switch to X1
OPER/CAL switch to OPER
MODE switch to SCOPE FAST
Sweep Initiation switch to AUTO
DIGITAL LOCATER to OFF

e. Apply the calibration signal (from the Sound Level Calibrator) to the SD301C SIGNAL INPUT connector. Observe the spectrum line to be at 10% (first major division line) of full scale on the oscilloscope.

f. Set MODE switch to PLOTTER. Using the % FULL SCALE switch, manually tune the analyzer to the calibration signal. (The dot will be at the peak of the spectrum line observed in Step e. above.)

g. On the X-Y recorder, actuate the servos. Use the Y-axis zero control and place the pen over the calibration point on the graph determined as follows:

1) To plot sound pressure level, place pen over 114 dB.

2) To plot normalized spectrum level, place pen over 99.23 dB as determined by:

$$S = L - 10 \log_{10} \Delta f \text{ dB}$$

$$= 114 - 10 \log_{10} 30$$

$$= 114 - 14.77$$

$$= 99.23 \text{ dB}$$

CAUTION

Both the INPUT RANGE fine attenuator and post filter GAIN switches are in the calibration signal "path", and, therefore affect the output signal level. If they cannot be preset using the actual data signal, any change of settings required after calibration must be compensated for by a corresponding change in dB on the recorder graph.

h. Position the calibration point (dot) on the oscilloscope (with position control) to correspond with the calibration level.

i. Place the X-Y recorder in standby mode and set the SD301C MODE switch to SCOPE FAST.

j. Remove the calibration signal and apply the data signal to the SD301C SIGNAL INPUT. The oscilloscope will display the Fourier analysis (normalized spectrum level) of the data signal to 10 kHz.

k. On the SD301C, press the MEMORY HOLD push button to capture the desired spectrum.

l. Set MODE switch to PLOTTER, Sweep Initiation switch to SINGLE/RESET, and press the SINGLE/RESET push button. The oscilloscope trace will reset to the left; the SINGLE/RESET indicator will not be lighted.

m. Energize the X-Y recorder servos and pen-down. (If automatic pen lift is connected to the SD301C, pen-down is automatically activated.)

n. Press the SINGLE/RESET push button. The X-Y recorder will produce a record in the time as internally set and as affected by sweep rate feedback.

At the end of the record, place the X-Y recorder in standby mode.

o. On SD301C, set MODE switch to SCOPE FAST, Sweep Initiation to AUTO, and press the MEMORY UPDATE push button. The analyzer will now accept new data for subsequent displaying and recording.

2.8 ANALYSIS OF RANDOM DATA (PSD)

2.8.1 Introduction

For analyzing signals with random content, an estimate of long-term power spectrum (or power spectral density characteristics) is desired. The SD301C performs a complete spectrum analysis in Real Time; that is, each analysis is performed on data with 2 degress of freedom. Therefore, the Model SD302 Ensemble Averager can be used with the SD301C to provide the desired estimate of the average spectrum characteristics of a random signal. The SD302 performs frequency domain averaging by examining an ensemble of spectrum functions, and then computing the average sum over a predetermined length of time.

The accuracy of the average spectral content determined from an ensemble average of spectrum functions is governed by a parameter known as the statistical degrees of freedom (n). This quantity can be computed as n = 2BT, where B is the analysis bandwidth and T is the length of time in seconds over which a data sample is examined.

Recall that on any given range of the SD301C, the analysis bandwidth, B, is essentially the reciprocal of the memory period, T; thus for all practical purposes, $B = \frac{1}{T}$. This means that on any range, the product BT is always equal to approximately 1. Since the number of degrees of freedom n = 2BT, it is seen that no matter which range of the SD301C Real Time Analyzer is selected, each statistically independent spectrum analysis produces a spectrum estimate with two degrees of freedom. Thus, virtually any desired statistical accuracy can be achieved by averaging over a sufficient number of statistically independent memory periods.

A rear-chassis connector J13, on the SD301C is wired to accept the interconnection cable from the SD302; no changes to the SD301C are required. For further details on the operation of the Model SD302, refer to the Instruction Manual for Model SD302 Ensemble Averager.

To establish a calibration level when using the SD301C and SD302 combination for PSD analysis, either the internal calibration signal from the SD301C or an externally applied calibration signal can be used. Both methods are described in the following paragraphs.

In the examples that follow, a flat random signal in the frequency range of 10 to 2,000 Hz at a level of 0.2 g^2/Hz will be considered. From g rms = $\sqrt{g^2/Hz \times BW}$, the overall level of 20 g rms is established. Using the 2K ANALYSIS RANGE, the effective BW is 6.4 Hz. (Refer to Table 2-4.)

Table 2-4. Memory Parameters

ANALYSIS RANGE UPPER LIMITS (Hz)	BANDWIDTH (Hz) (3 dB FILTER)	*RESOLUTION (Hz)	EFFECTIVE (NOISE) BANDWIDTH (Hz)
50,000	150	100	160
20,000	60	40	64
10,000	30	20	32
5,000	15	10	16
2,000	6	4	6.4
1,000	3	2	3.2
500	1.50	1	1.6
100	0.30	0.20	0.32
50	0.15	0.10	0.16
10	0.03	0.02	0.032

*Spacing of filter locations.

2.8.2 PSD Calibration Using Internal Cal Signal

Assume that the random data sample of 20 grms is on-line and is based on a known sensitivity of 10 mV rms/grms. The following steps are employed for calibration with an X-Y recorder.

a. Interconnect SD301C and SD302; apply power to the SD301C and all associated instrumentation equipment. (Refer to Paragraph 2.2 for powering procedure.)

b. Calibrate the X and Y axis of the recorder as described in Paragraph 2.3 for lin or log frequency and log spectrum except calibrate the Y axis so that a 10 dB change produces a 1 decade change on the chart to establish a two times the log (or g^2) condition.

NOTE

Verify that the SD301C FREQUENCY OUTPUT (X-axis) is properly calibrated. Refer to Paragraph 2.3 Steps e. and f.

c. Set the SD301C front-panel controls as follows:

ANALYSIS RANGE to 2K
FREQUENCY MARKERS to OFF
Press MEMORY UPDATE Mode Push Button
OPER/CAL Switch to OPER
MODE Switch to SCOPE FAST
Sweep Initiation Switch to AUTO
DIGITAL LOCATER to OFF

d. Apply the data signal to the SIGNAL INPUT (front panel or J24 rear connector) to enable presetting the following operating parameters. Set the INPUT RANGE switch to .316 Vrms and the 1 dB attenuator for an input level indication which shows only occasional input overload conditions. Increase the post filter GAIN to X10, 20 or 26 dB gain being certain that OUTPUT overload conditions are not experienced. This permits full use of the dynamic range of the SD301C to obtain the optimum for random signal or transient analysis.

CAUTION

Both the INPUT RANGE fine attenuator and post filter GAIN switches are in the calibration signal "path", and, therefore, affect the output signal level. If they cannot be preset using the actual data signal, any change of settings required after calibration must be compensated for by a corresponding change in dB on the recorder graph.

e. Establish the SPECTRUM-CAL setting as follows:

$$CAL = \frac{(grms \times 1.13)^2}{\text{Effective BW (from Table 2-4)}}$$

NOTE

The factor of 1.13 is used since the SD301B employs quasi-peak* detection. The resulting relationship of rms random = 1.13 times rms sine must therefore be considered when calibrating with a sine wave. The effective BW on the 2-kHz analysis range is 6.4 Hz.

*quasi-peak = envelope rectifier followed by sampling detector.

Therefore:

$$CAL = \frac{(31.6 \times 1.13)^2}{6.4}$$

$$= \frac{1273.5}{6.4}$$

$$= 199.0\ g^2/Hz$$

From this the following can be established:

SPECTRUM-CAL

0 dB	=	199 g^2/Hz
-10 dB	=	19.9 g^2/Hz
-20 dB	=	1.99 g^2/Hz
-30 dB	=	0.199 g^2/Hz
-40 dB	=	0.0199 g^2/Hz

f. Set the SD301C MODE switch to EXT AVGR and set the SD302 to the PLOTTER mode.

g. Set OPER/CAL switch to SPECTRUM-CAL -30 dB, energize the recorder servo, and adjust the Y axis of the recorder using the zero adjust so that the pen lines up with 0.199 g^2/Hz in the upper decade of the graph. (The data level is expected to be 0.2 g^2/Hz.) After adjusting the recorder, place it in standby; then set the OPER/CAL switch to OPER.

NOTES

1) If sweep rate feedback is desired on the SD302, refer to the SD302 manual for connection details.

2) On SD302 rear chassis, select SLOW or NORMAL sweep rate. In SLOW sweep, the first 64-synthesized filter locations are scanned slowly to enhance a log frequency display by not exceeding the recorder mechanical slewing rate.

3) For automatic pen lift connection details, refer to Paragraph 2.4.

h. On the SD302, select the desired NO. OF ENSEMBLES to be averaged. With the data signal being applied to the input of the SD301C, press the AVERAGING START push button.

NOTES

1) The duration that the data signal must be applied is a function of the product of the MEMORY PERIOD and the chosen NO. OF ENSEMBLES. For example, in the 2-kHz analysis range, the memory period is 0.25 seconds. If 64 ensembles are to be averaged, the data signal must be applied for a minimum duration of 16 seconds. The AVERAGING STOP switch/indicator indicates the completion of averaging.

2) The averaging process may be observed on an oscilloscope. Refer to the SD302 manual for connection details. The SD302 is then operated in SCOPE mode.

i. Upon completion of the averaging, engage the servo section of the X-Y recorder and press the PLOTTER SWEEP push button, initiating a record. The record will be produced in the time as selected and as affected by sweep rate feedback.

2.8.3 PSD Calibration Using External Cal Signal

If an external calibration signal from a reference oscillator is to be used to establish a specific full-scale graph g^2/Hz level, the calibration procedure is the same as Paragraph 2.8.2 except Steps e., f. and g. (substitute steps are given below).

Assume for this example also that the same 20g rms random data signal with a sensitivity of 10 mV rms/grms is to be analyzed. Perform Steps a. through d. of Paragraph 2.8.2; then proceed as follows:

SUBSTITUTE for STEP e.:

Establish the CAL reference level as follows:

Since the data level is expected to be 0.2 g^2/Hz, select 1.0 g^2/Hz for full scale on the recorder.

Determine external CAL g rms for full scale.

$$\text{Cal (g rms} \times 1.13)^2 = \text{Full Scale} \times \text{Effective BW (Refer to Table 2-4)}$$

$$\text{CAL g rms} = \frac{\sqrt{1.0 \times 6.4}}{1.13}$$

$$= \frac{2.53}{1.13}$$

$$= 2.24$$

From this find external CAL mV rms for full scale.

$$\text{CAL mV rms} = \text{Signal Sensitivity} \times \text{CAL g rms}$$

$$= 10 \text{ mV rms/g rms} \times 2.24 \text{g rms}$$

$$= 22.4 \text{ mV rms}$$

SUBSTITUTE for STEP f.:

Set OPER/CAL switch to OPER. Apply to the SIGNAL INPUT a 1-kHz calibration signal at the CAL mV rms level as calculated above. With the MODE switch set to MANUAL and using the % FULL SCALE switch, manually tune the SD301C to 1 kHz. Be certain that the signal level is at the "peak" of the filter, by observing the pen level indication on the X-Y recorder while slightly varying the oscillator frequency. Adjust the Y axis of the recorder using the zero adjust so that the pen indicates full scale on the graph. After adjusting the recorder, place it in standby.

SUBSTITUTE for STEP g.:

Set the SD301C MODE switch to EXT AVGR and set the SD302 to the PLOTTER mode.

Perform Steps h. and i. of Paragraph 2.8.2.

NOTE

For calibration of both the SD301C and SD302 as a system, an additional calibration step may be performed. If the SD301C is manually tuned to a specific harmonic component, the SPECTRUM outputs of the analyzer (LIN STEP, LIN and LOG) are simple d-c voltages representing the Fourier magnitude of the harmonic to which the analyzer is tuned. By selecting a number of ensembles and actuating the AVERAGING START control, this d-c voltage will be transferred to all 500 frequency locations of the SD302 unit, even though the MODE switch is NOT in the EXT AVG position.

When the AVERAGING STOP light indicates a completed average, a scope display of the contents of the AVERAGER will show a straight-line equivalent of the calibration signal PSD level. For X-Y recorder readout, the SD302 in the PLOTTER mode will provide a stable d-c voltage for recording purposes. Therefore, by transferring a d-c voltage to the AVERAGER, an amplitude calibration of the analyzer/averager combination as a system is performed.

2.8.4 PSD Calibration Using Tape Recorded Cal Signal

If a tape recorded calibration signal is available that is representative of a known grms level, the calibration procedure is the same as Paragraph 2.8.2 except Steps e., f., and g. (substitute steps are given below).

The example used in this procedure assumes that a 1-kHz sine wave calibration signal at a level representing 20g rms has been recorded along with the example 20 g rms random data signal. To calibrate, perform Steps a. through d. of Paragraph 2.8.2; then proceed as follows:

SUBSTITUTE for STEP e.:

Establish the CAL g^2/Hz level as follows:

Measure the rms level of the recorded calibration signal to determine the tape recorder sensitivity (or the data signal sensitivity). For this example, assume that 200 mV rms was measured.

$$\text{Signal Sensitivity} = \frac{\text{Tape Output Level}}{\text{Calibration Level}}$$

$$= \frac{200 \text{ mV rms}}{20 \text{ grms}}$$

$$= 10 \text{ mV/g}$$

Determine the g^2/Hz CAL level:

$$\text{CAL} = \frac{(\text{g rms} \times 1.13)^2}{\text{Effective BW (See Table 2-1)}}$$

$$= \frac{(20 \times 1.13)^2}{6.4}$$

$$= 79.9 \; g^2/\text{Hz}$$

Now determine the INPUT RANGE switch setting required for the calibration signal. Because the data signal measured 200 mV rms, during data analysis the INPUT RANGE switch would be set to .316 Vrms. However, the calibration signal is 20 dB higher (79.9 g^2/Hz versus 0.2 g^2/Hz), so for this example the INPUT RANGE switch would be set to 3.16 Vrms while calibrating.

SUBSTITUTE for STEP f.:

Set the OPER/CAL switch to OPER and MODE switch to MANUAL. Using the % FULL SCALE switch, tune SD301C to 1 kHz. Ensure signal level is at the "peak" of the filter; observe the pen level on X-Y recorder while tuning.

Using the recorder zero adjust, calibrate the Y-axis so pen lines up with 0.799 g^2/Hz in the upper decade of the graph.

After recorder is calibrated, place it in standby mode.

SUBSTITUTE for STEP g.:

On SD301C, set INPUT RANGE switch to .316 Vrms and MODE to EXT AVGR.

Set the SD302 to PLOTTER mode.

Perform Steps h. and i. of Paragraph 2.8.2.

2.9 TRANSIENT ANALYSIS

2.9.1 General

For normal operation of the TRANSIENT CAPTURE mode, the DIGITAL LOCATER switch is set to TRANSIENT CAPTURE. The number of samples to be loaded into memory (001 to 999) is then determined by the numerical value (not the percentage value) of the % FULL SCALE switch.

NOTE

If the DIGITAL LOCATER is not set to TRANSIENT CAPTURE, 1,500 data points are loaded into memory. The following paragraph explains why this is not desirable.

Because a cosine squared weighting function is used in deriving the Fourier spectrum information, the absolute magnitude of the spectrum response of the transient input is dependent on the exact location of the transient in memory. Because loading of the memory is normally triggered by the transient itself, the % FULL SCALE switch should be used to place the transient at a location that corresponds to the peak of the cosine squared weighting function.

2.9.2 Verification of the Internal Calibration Signal

This procedure should be performed at least once to verify that the internal calibration signal can be related to a known pulse. Once the relationship is established, it need not be performed again. Proceed as follows:

a. Connect the FREQUENCY LOG and SPECTRUM LOG outputs to the X and Y inputs of a display oscilloscope.

b. Connect the MEMORY OUTPUT (J22) to a high frequency (15 MHz) monitor oscilloscope; trigger the scope on the MEMORY SYNC (J21) output.

Note that the memory sync pulse does not occur at the beginning of the memory, but is delayed approximately 10 microseconds. Hence, the cell location "1" will appear 1 cm from the right-hand side of the monitor scope if only one memory cycle (100 microseconds) is displayed.

c. Perform normal calibration as described in Paragraph 2.4.1, Oscilloscope Setup. Assuming that the data input level will reach but not exceed 1 Vrms, calibrate with the INPUT RANGE switch set to 1 Vrms. (Any INPUT RANGE setting can be used depending on the expected data level during normal operation.)

An external input pulse is required for this check. It can be developed by applying a d-c voltage (1.4 Vdc for the 1 Vrms range) to the SIGNAL INPUT with the AC/DC switch in AC position. With the TRANSIENT TRIGGER switch set to INT, the AC/DC switch is set to DC and a transient-type pulse is developed in the analyzer input.

The pulse time duration in seconds must be known; so with the DIGITAL LOCATER set to TRANSIENT CAPTURE, the % FULL SCALE switch is used to limit the time interval of the pulse that is captured in the analyzer memory.

d. Prepare the SD301C for the test as follows:

1) Apply 1.4 Vdc to the SIGNAL INPUT.

2) Place the AC/DC switch to AC.

3) Set INPUT RANGE to 1 Vrms; set fine switch to 0/CAL.

4) Place TRANSIENT TRIGGER to INT.

5) Set DIGITAL LOCATER to TRANSIENT CAPTURE, and % FULL SCALE to 125. (This setting will result in a captured pulse time-interval of 1/12 of the memory period.)

6) Set ANALYSIS RANGE switch to 2K. (This will allow a rapid memory loading time.)

7) Press TRANSIENT CAPTURE push button.

8) Set the remaining controls to their normal operating positions.

The analyzer is now ready to capture the pulse that will occur when the AC/DC switch is placed to DC.

e. Place the AC/DC switch to DC; all input level indicators should light except the OVERLOAD lamp. Observe the following results:

1) The monitor oscilloscope displaying the memory contents will show a pulse whose leading edge is at memory cell location 1,375 and lasts for 125 locations.

2) The display oscilloscope will not show an analysis because of the attenuation of the weighting function.

Because the Fourier analysis is not seen, it is necessary to move the captured pulse to the center of the memory; i.e., move the leading edge of the pulse to approximately cell number 700. (This is not critical.) Proceed as follows:

f. Set the ANALYSIS RANGE switch to 50 Hz. (This will provide time to observe the memory recirculating process.)

g. Place the AC/DC switch to AC. (Disconnect the input if desired to prevent any stray pickup.)

NOTE

Read both parts of the following Step h. before pressing the MEMORY UPDATE push button.

h. Press the MEMORY UPDATE push button and watch the pulse travel through the memory (from right to left on the monitor oscilloscope).

When the pulse is approximately centered, press the HOLD button.

i. On the display oscilloscope, observe the Fourier amplitude spectrum of the captured transient pulse. Its peak amplitude will be 9 dB down from the original internal calibration signal.

NOTE

Because the Fourier amplitude spectrum of a pulse has the units of volt-seconds, the peak amplitude of this spectrum will change by either changing the input voltage level or the time duration of the pulse.

This concludes the verification of the internal calibration signal relative to a pulse of a known time duration and amplitude. The calibration point that has been established in the preceding test is for a 1 Vrms pulse having a time duration of 1/12 of any selected memory period (in seconds).

2.9.3 Transient Analysis Using Internal Calibration Signal

The following example is presented as an aid in establishing the exact g-seconds level. In this example, the normalized pickup sensitivity is 10 mV/g; the pulse duration is 0.008 seconds (which is 1/12 of the 0.1-second memory period of the 5K ANALYSIS RANGE). Because the maximum "g" level expected is 100g's, select the 1V range. With these conditions, the peak amplitude point (as verified in Paragraph 2.9.2) would equal:

100g x 0.008 second = 0.8 g-seconds

Hence, the internal calibration signal (being 9 dB higher than this level) would equal 2.28 g-seconds.

For data pulses having various time durations, an appropriate memory (ANALYSIS RANGE) should be selected. Any duration pulse up to one-third of a memory period can be analyzed.

2.10 NARROWBAND SPECTRUM RESOLUTION AT FREQUENCIES TO 1 MHz

The analysis frequency range of the SD301C can be extended upward to 1 MHz by addition of the Model SD303 Spectrum Translator and associated reference oscillator source, normally a frequency synthesizer. A rear-chassis connector, J15, on the SD301C is wired to accept the interconnection cable from the SD303. Note that the Model SD302 Ensemble Averager, described above, can also be used along with the SD301C and SD303 to provide long-term power spectrum analysis of random signals. For further operational details, refer to Instruction Manual for Model SD303 Spectrum Translator.

2.11 SONIC AND VIBRATION ANALYSIS OF ROTATING MACHINES

When analyzing vibration in rotating machinery, a common problem of compensating for variations in speed can be overcome by using the Model SD304 Signature Ratio® Adapter with the SD301C. Use of the Model SD304 also allows comparison of spectrum signatures taken at different speeds. The Model SD304 accepts a speed reference input, usually from a 1-per-revolution tachometer attached to the item under test, and generates appropriate sampling pulses for use by the SD301C. As the item under test and its tachometer output increases or decreases in speed, the sampling pulse rate output of the SD304 changes by the same proportion. Thus, the total frequency range of analysis of the SD301C is made to vary so that the spectrum display always represents a preselected number of harmonic orders referenced to the speed (tach) input.

A rear-chassis connector, J14, on the SD301C, is wired to accept the interconnection cable from the SD304; no changes to the SD301C are required. For further details on the operation of the Model SD304, refer to Instruction Manual for Model SD304 Signature Ratio® Adapter.

2.12 SPECTRUM LIN SQUARED OUTPUT (Optional)

For some applications such as random signal analysis using the Model SD302 Ensemble Averager, it is desired to observe and record the squared value of a spectrum magnitude. An effective squared value can be obtained under certain conditions by doubling the SPECTRUM LOG output prior to recording. However, if it is desired to display or record the squared value of the spectrum linear amplitude, Output Amplifier Assembly No. 11430-3 can be used in place of Assembly No. 11430-1 (A21). Assembly No. 11430-3 provides a SPECTRUM LIN SQUARED output along with the normal SPECTRUM LIN STEP, LIN, and LOG outputs. When Assembly No. 11430-3 is used, the squared output is available at rear-chassis connector J10.

2.13 EXTERNAL SAMPLING AND TAPE SPEED NORMALIZATION

External A-D sampling control is facilitated by using rear-chassis connector J14, normally used with the SD304 Signature Ratio®Adapter described in Paragraph 2.11.(The sampling control circuitry is described in Paragraph 3.3.2 in Section III of this manual.) To control the sampling externally, proceed as follows:

a. Ground pin 2 of J14; this disables the internal sampling control.

b. To cause a sample to be taken, apply a transition from 0V to 3.5V to pin 20 of J14.

NOTE

Because the external sampling pulse applied to J14-20 is routed directly to TTL logic, the wave shape must have a rise time of 0.5 microsecond or less, and a minimum duration of 2 microseconds. A slower transition can cause multiple triggering, resulting in erratic sampling.

For normal internal sampling, both pins 2 and 20 of J14 must be either high (+3.5V) or open.

2.14 EXTENDED UPPER FREQUENCY COVERAGE

The upper frequency limit of any ANALYSIS RANGE can be extended 10%. This is accomplished by grounding pin 18 of J15. (This is automatically done when using the Model SD303 Spectrum Translator, described in Paragraph 2.8, to eliminate certain spectrum reflections caused by the translation operation.) With pin 18 of J15 grounded, each ANALYSIS RANGE is offset by 10%; for example, the 20-kHz range becomes 2 kHz to 22 kHz; the 10-kHz range becomes 1 kHz to 11 kHz, etc.

Be sure to remove the ground from pin 18 to J15 to return the instrument to normal operation.

NOTE

If the intensity markers are slightly offset from the frequency markers, adjust A22R14, TRANSLATOR OFFSET ADJUST, accessible through a hole in the top cover.

SECTION III

CONCEPT AND THEORY OF OPERATION

3.1 CONCEPT OF OPERATION

The Model SD301C Real Time Analyzer operates as a frequency-tuned bandpass filter to convert the input signal from the time domain to the frequency domain. (See Figure 3-1.)

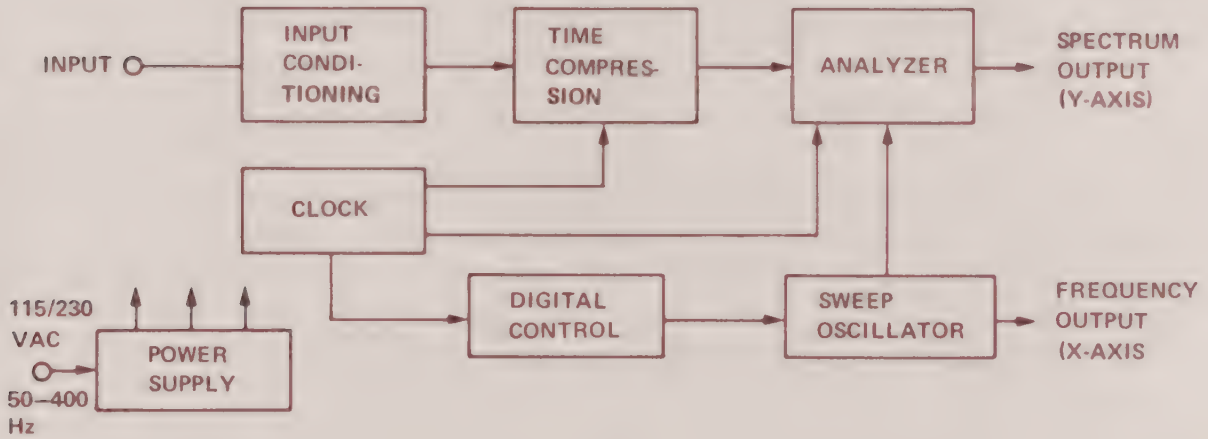


Figure 3-1. Concept of Operation

The time-compressed input signal is frequency analyzed using 500 or 1000 synthesized filter locations that are tuned by a built-in sweep generator. Frequency (X-axis) and spectrum (Y-axis) outputs are provided in linear step, linear smooth, and log smooth form. An internal marker generator and calibrate signal facilitate oscilloscope and X-Y recorder calibration on all ranges. Time markers, sweep rate, and operational modes can be controlled by application of external signals.

3.2 SIMPLIFIED BLOCK DIAGRAM DESCRIPTION

As depicted in Figure 3-1, the following description is divided into seven main parts: input conditioning, time compression, analyzer, sweep oscillator, digital control, clock, and power supply. Figure 3-2 is a block diagram of the Model SD301C.

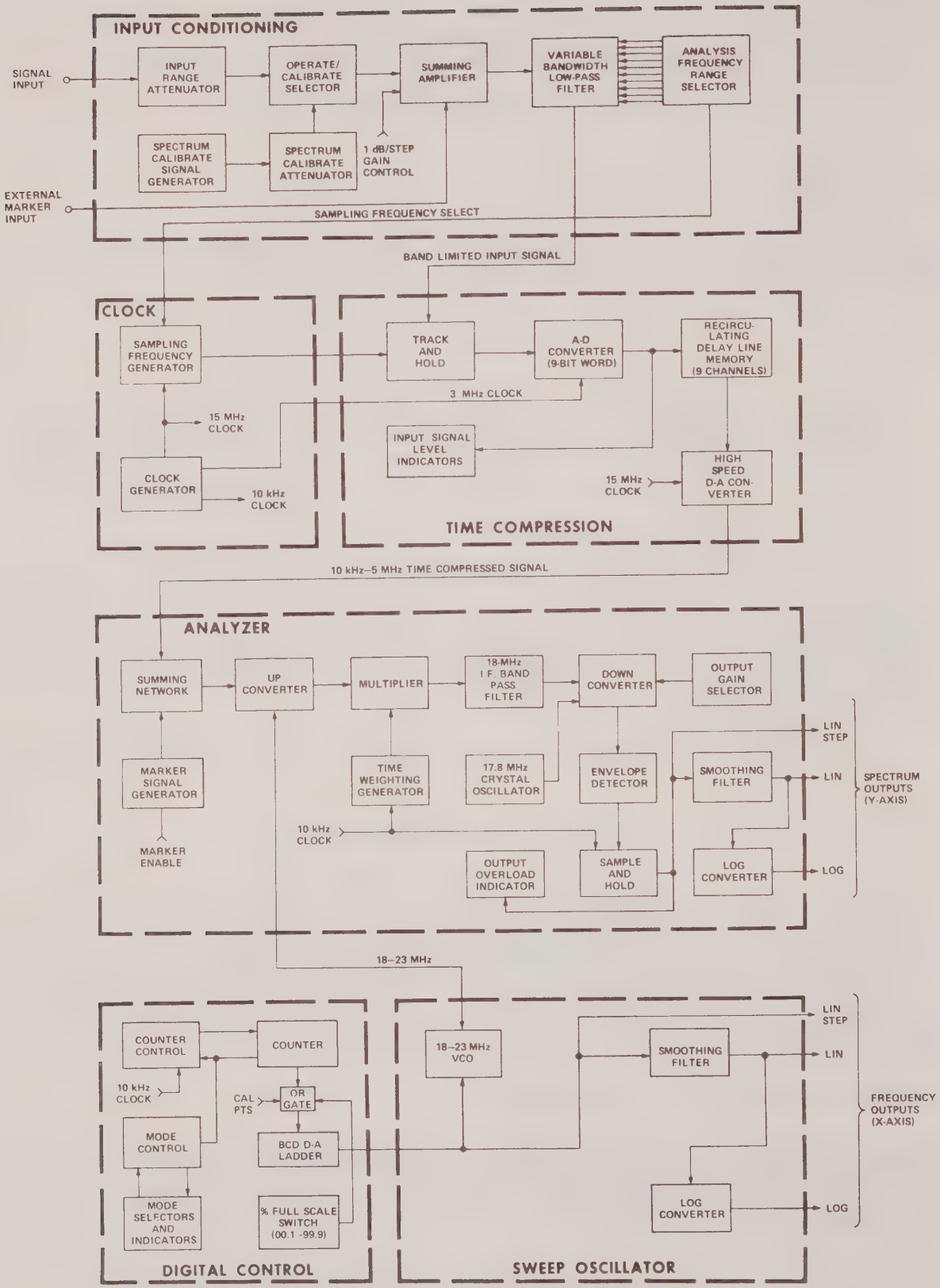


Figure 3-2. Block Diagram Model SD301C Real Time Analyzer

3.2.1 Input Conditioning

The input signal to be analyzed is applied to the INPUT RANGE attenuator. In the OPERATE mode, the properly attenuated signal is routed through the operate/calibrate selector, amplified by the summing amplifier, and applied to a variable-bandwidth low-pass filter. Note that under control of the front-panel FREQUENCY MARKER switch, externally applied markers can be summed with the input signal. Internally generated markers are applied in the analyzer section which is described later in Paragraph 3.2.3.

The upper frequency limit, the filter bandwidth, and the memory period are simultaneously selected by the ANALYSIS RANGE selector. For example, in the 50-kHz ANALYSIS RANGE setting, the analyzer accepts input signals up to 50 kHz (UPPER LIMIT), the synthesized filter bandwidth is150 Hz, and the time allotted for filling the memory is 0.01 second. The output of the selected filter is routed to the time compression section.

3.2.2 Time Compression

The band-limited input signal is sampled at the rate of three times the UPPER (frequency) LIMIT (Hz), and then applied to a 9-bit A-D (analog to digital) converter. Each time a sample is taken, a new 9-bit binary digital word (or number) is generated that corresponds to the signal amplitude at the time of the sample. These digital numbers are sensed by the INPUT signal level indicator circuit. This circuit provides a front-panel indication of the INPUT SIGNAL level. (Refer to Paragraph 1.3 in Section I.)

The 9-bit binary numbers are placed in the recirculating memory in such a manner that the time between samples is compressed, thus effectively increasing the frequency of the basic input signal. (This technique is described in detail in Paragraph 3.3.2.)

The output of the delay line memory is transferred to a high-speed D-A (digital to analog) converter. The D-A converter reconstructs a speeded-up waveform of the original input signal.

For example, in the 10 kHz ANALYSIS RANGE, the speed-up factor is 500; that is, an input signal band of 20 Hz to 10 kHz is speeded up to a signal band of 10 kHz to 5 MHz. This time-compressed signal is routed to the analyzer section.

3.2.3 Analyzer

The 10-kHz to 5-MHz time-compressed signal is up-converted to an 18-MHz I.F. signal. This is done by mixing the 10-kHz to 5-MHz signal with an 18- to 23-MHz swept tuning signal. The tuning signal is incremented in either 500 10-kHz intervals or 1000 5-kHz intervals, from 18 to 23 MHz.

Also at this point, internally generated markers can be applied to the SPECTRUM signal by setting the front-panel FREQUENCY MARKERS switch to INT. In this condition, 10 equally-spaced frequency marker "pips" appear.

Because the data record in memory is 100 microseconds long, a single 10-kHz bandpass filter (18 MHz center frequency) can analyze the entire spectrum by responding successively to the adjacent 10-kHz segments of frequency components. This technique provides 500 synthesized 10-kHz filter locations.

The output of the up-converter is multiplied with a $\sin^2$ wave. This time-weighting technique modifies the shape of the filter output response without changing the signal's center frequency, and effectively eliminates the spectra produced by the effects due to a finite record length in the memory.

The 18-MHz I.F. signal is filtered, amplified, and then down converted by mixing it with a 17.8-MHz signal from a crystal-controlled oscillator. The 200-kHz difference frequency is detected. The detector output is applied to a sampler circuit. The sampler, synchronized to the time weighting signal, selects the proper value from the detected envelope. The selected samples are amplified and provided as the SPECTRUM LIN STEP output. This output provides 500 incremental linear voltage steps from 0V to 5V; each step is proportional to the signal amplitude of the synthesized filter location (described above).

The SPECTRUM LIN STEP signal is filtered to provide a smooth SPECTRUM LIN output. The SPECTRUM LIN signal is also applied to a log converter which produces a 1V full-scale smooth SPECTRUM LOG output that is proportional to the SPECTRUM LIN output.

3.2.4 Sweep Oscillator

The sweep oscillator section generates an 18- to 23-MHz signal, linearly stepped in 500 or 1000 increments, for use in the analyzer section. During a spectrum scan, the 10-kHz clock signal drives a stepped-ramp generator that produces 500 or 1000 incremental voltage steps from 0V to 5V. The voltage steps are applied to the voltage-controlled oscillator (VCO) causing its output frequency to be stepped from 18—23 MHz. The VCO frequency is routed to the up converter in the analyzer section.

The 0V to 5V linear steps are also available at the FREQUENCY LIN STEP output connector for use in driving the X-axis of a recorder. The FREQUENCY LIN STEP signal is filtered to provide a smooth FREQUENCY LIN output. The FREQUENCY LIN output is also applied to a log converter which produces a 1V full-scale smooth FREQUENCY LOG output that is proportional to the FREQUENCY LIN output.

3.2.5 Digital Control

The digital control section generates the operational mode control functions based on the clock timing signals, front-panel control switch and push button settings, and/or externally applied control signals. For example, with the OUTPUT MODE switch set to SCOPE FAST, SCOPE SLOW, or PLOTTER, the rate at which the analyzer signal spectrum is swept and the associated FREQUENCY OUTPUT signals are controlled by the internally generated clock signals. In the EXT AVGR mode, sweep control is from an external source such as the SD302 Ensemble Averager. In MANUAL mode, the analyzer sweep and FREQUENCY OUTPUT signals are manually controlled by the front-panel % FULL SCALE switch.

3.2.6 Clock

The clock generates the timing signals that synchronize all the internal operations. The basic clock frequency source is a 15-MHz crystal-controlled oscillator. A series of digital divider circuits (flip-flops) are used to divide the 15-MHz signal down to the various clock and sampling frequencies.

3.2.7 Power Supply

The power supply uses conventional solid-state diode rectification and electronic voltage regulators to provide all circuit d-c operating voltages: +28V, +12V, +5V, and -12V. All components are conservatively rated to provide additional power for operating ancillary units such as the Model SD302 Ensemble Averager and Model SD42 Memory. Either 115V or 230V a-c primary power (switch selectable) can be applied.

3.3 DETAILED BLOCK DIAGRAM DESCRIPTION

Throughout the following description, each of the major sections is depicted by a functional block diagram. The various circuits shown in block form are also outlined with a dashed line and identified by their alphanumeric designator in parenthesis, such as Clock (A2).

3.3.1 Input Conditioning (See Figure 3-3.)

The purpose of this circuitry is to provide a 5V p-p full-scale band-limited signal to the A-D (analog-to-digital) converter in the time-compression section.

The audio signal to be analyzed is routed to the INPUT RANGE (Vrms) switch attenuators. In combination, a total of 49 dB attenuation is available in calibrated 1 dB steps; the coarse switch provides 40 dB attenuation in 10 dB steps, and the fine switch provides 9 dB attenuation in 1 dB steps. This switch arrangement allows any input signal between 0.1 Vrms (minimum) and 28.2 Vrms (maximum) to be adjusted for full scale.

With the FREQUENCY-CAL/SPECTRUM-CAL switch in OPER position, the properly attenuated input signal is applied to input circuit card (A32). Here the signal is buffered and applied to the input of a variable-bandwidth low-pass filter. Also at this point, externally applied marker signals can be summed with the input signal via the FREQUENCY MARKERS switch. With a 1 Vrms marker input signal, the output markers displayed are approximately -20 dB below full scale on any range.

The actual bandwidth of the variable-bandwidth low-pass filter is always 1.1 times the bandwidth as selected by the front-panel ANALYSIS RANGE switch. The band-limited signal is amplified and then routed to the time compression circuitry.

3.3.2 Time Compression (See Figure 3-4.)

The time-compression circuitry samples the conditioned band-limited input signal at the rate of three times the upper frequency limit of any selected ANALYSIS RANGE. Note that according to sampling theory, a signal can be completely reconstructed from at least two samples taken at twice the highest signal frequency. The samples are then converted to 9-bit binary digital words and inserted into a recirculating delay line. The speeded-up digital words are then converted to an analog signal whose waveshape is that of the original input signal, but whose frequency is from 100 (50-kHz range) to 500,000 (10-Hz range) times the original input frequency.

The conditioned input signal is applied to a buffer on card A15. The buffer provides a 5V p-p full-scale output that varies about a 2.5V fixed d-c bias. Shifting the 0V reference level to 2.5 Vdc automatically establishes the sign of the signal voltage in the subsequent A-D conversion.

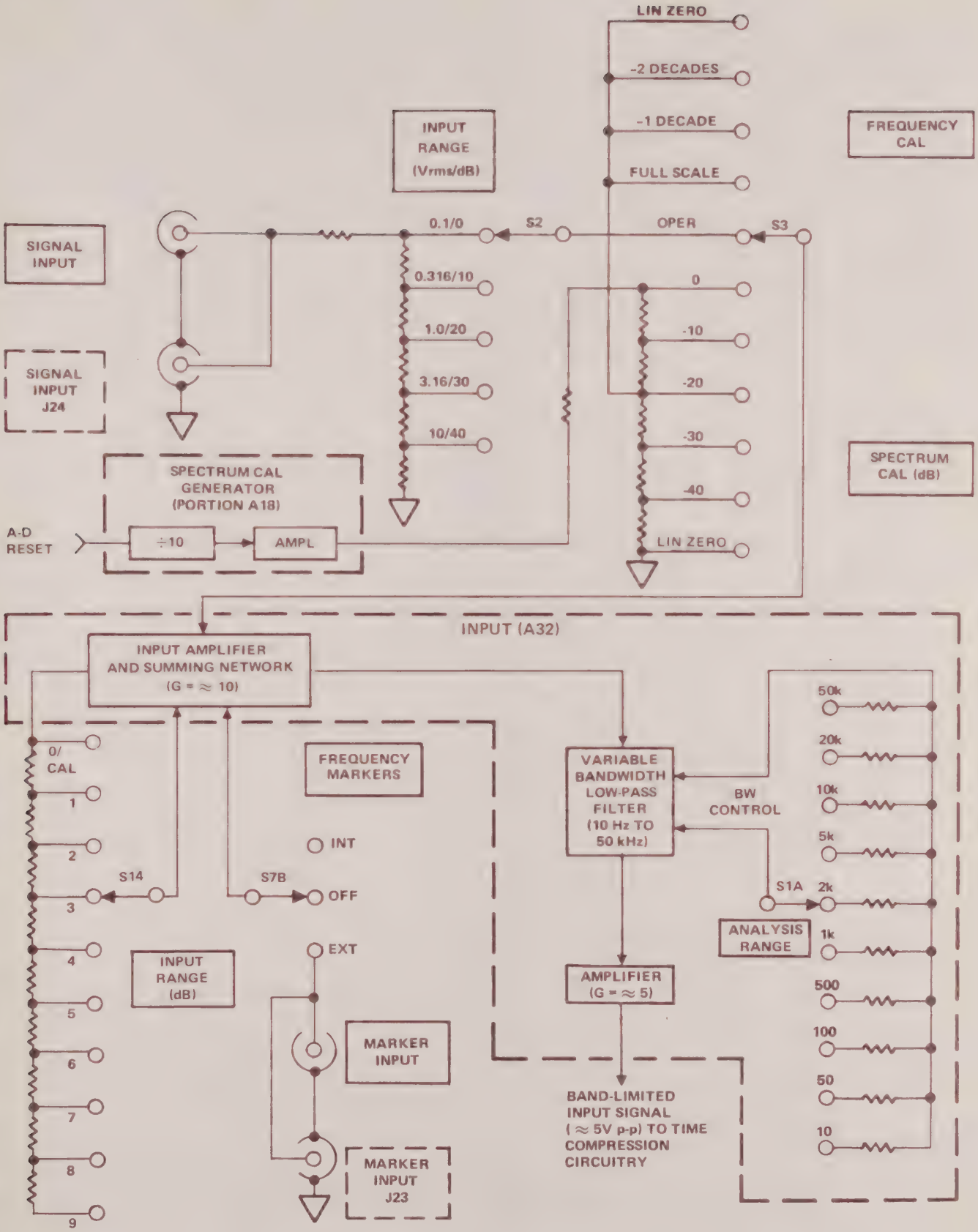


Figure 3-3. Functional Block Diagram of Input Conditioning Section

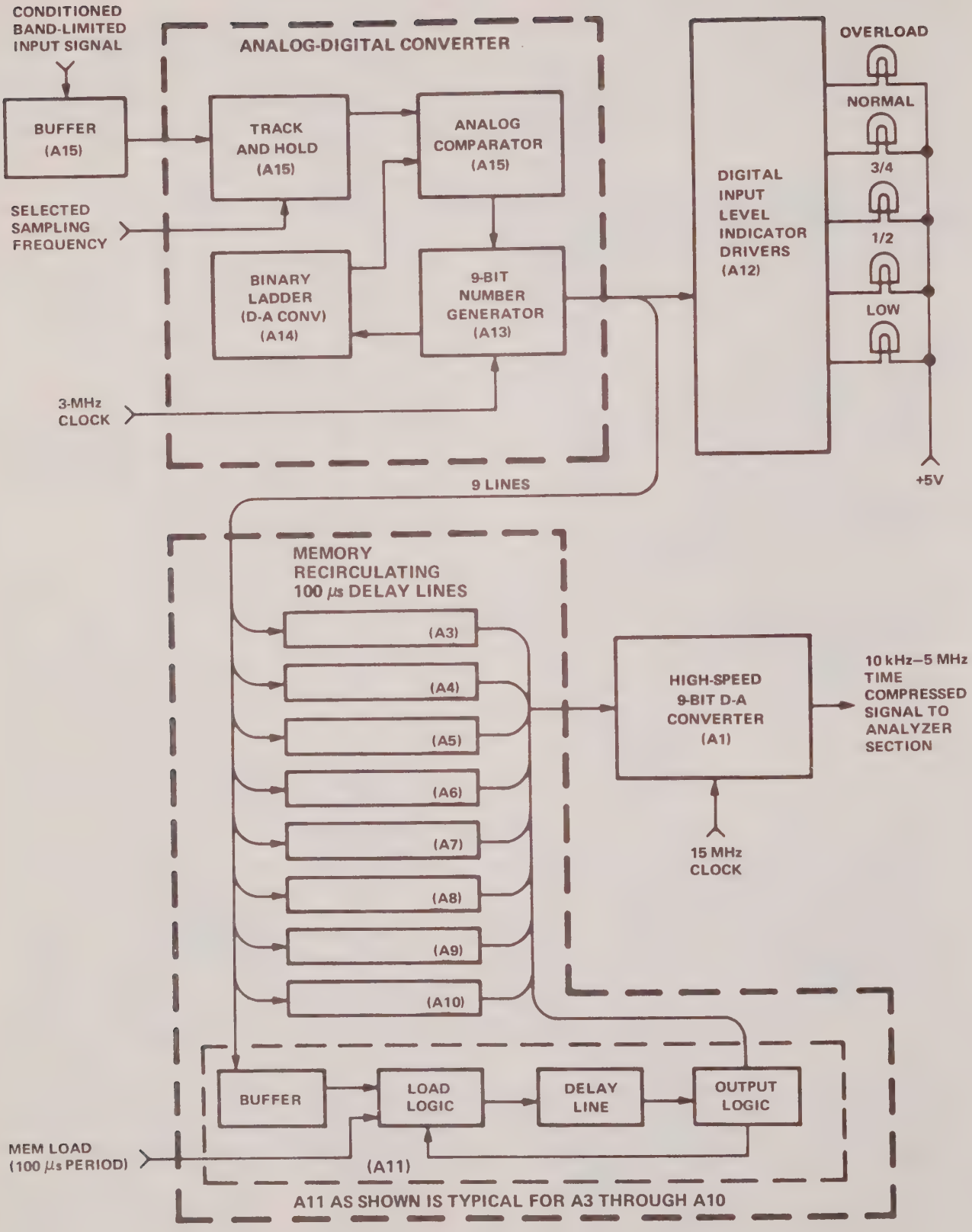


Figure 3-4. Functional Block Diagram of Time Compression Section

The A-D converter comprises the sample-and-hold and analog comparator on circuit card A15, the 9-bit number generator (A13), and D-A converter (A14). The method of A-D conversion used here is called "successive approximation". In this closed loop circuit, the comparator compares each sample to a voltage which is the D-A conversion of the number generator output. The comparator senses whether the analog version of the number generator is larger or smaller than the input and accordingly directs the number generator to a smaller or larger next approximation.

For example, in the 10-kHz ANALYSIS RANGE, a sampling frequency of 30 kHz (33-microsecond period) is used. Once each 33-microsecond interval the amplitude of the conditioned analog input signal is sampled. Each sample is held allowing it to be compared to various levels of d-c voltage produced by the binary ladder (D-A converter). (See Figure 3-4.)

As previously stated, the a-c signal output of the buffer is 0V to 5V full scale varying about a 2.5V d-c bias level. The first comparison determines the "sign bit" which is the most significant bit (MSB). That is, if the particular sample is greater than 2.5V the sign is positive; if less than 2.5V, the sign is negative. Now, if the sample is greater than 2.5V, the binary ladder produces a d-c level halfway between 2.5V and 5V, or 3.75V, which is compared to the sample. If the sample is greater than 3.75V, the ladder produces 4.375V (halfway between 3.75V and 5V). If the sample is less than 3.75V, the ladder produces 3.125V (halfway between 2.5V and 3.75V). Continuing in the manner just described, a total of nine successive approximations are made, producing a 9-bit binary digital number (word). The value of this digital word is proportional to the amplitude of the particular sample. In like manner as just described, each sample of the analog input signal is converted into a 9-bit word.

After each sample is converted, it is parallel transferred into the nine memory channels, one memory channel for each bit-position of the 9-bit word. A buffer at the input of each memory channel temporarily stores the data until the proper time for it to be loaded into the memory channel "delay line". (The expression "delay line" is used here to describe the dynamic operation of three MOS shift register memory elements; their operation is described in the following paragraph.) The nine memory channels are identical; therefore, only one is described.

See the block diagram of Figure 3-5. The "delay line" comprises three 500-bit MOS shift registers. For purpose of discussion, they have been numbered: 1, 2, and 3, in Figure 3-5. The "delay line" is continuously loaded and unloaded at a bit-rate of 15 MHz; however, each individual shift register is operated at only 5 MHz. This is accomplished by dividing the 15-MHz clock into 3-phase 5 MHz; that is, assigning "ϕA" to any 15-MHz shift pulse, the following pulses would be in succession, ϕB, ϕC, ϕA, ϕB, ϕC, etc. In this way, the three shift registers (see Figure 3-5) are sequentially loaded (and unloaded for outputing and recirculation) in the order: No. 1, 2, 3, 1, 2, 3, etc. at an individual bit-rate of 5 MHz, and at an overall bit-rate (for the 3-register combination) of 15 MHz.

Although the "delay line" operation involves three 500-bit shift registers that are sequentially shifted, for sake of clarity, the following description of time compression treats the total 1500 bit spaces of the "delay line" as being in one continuous series.

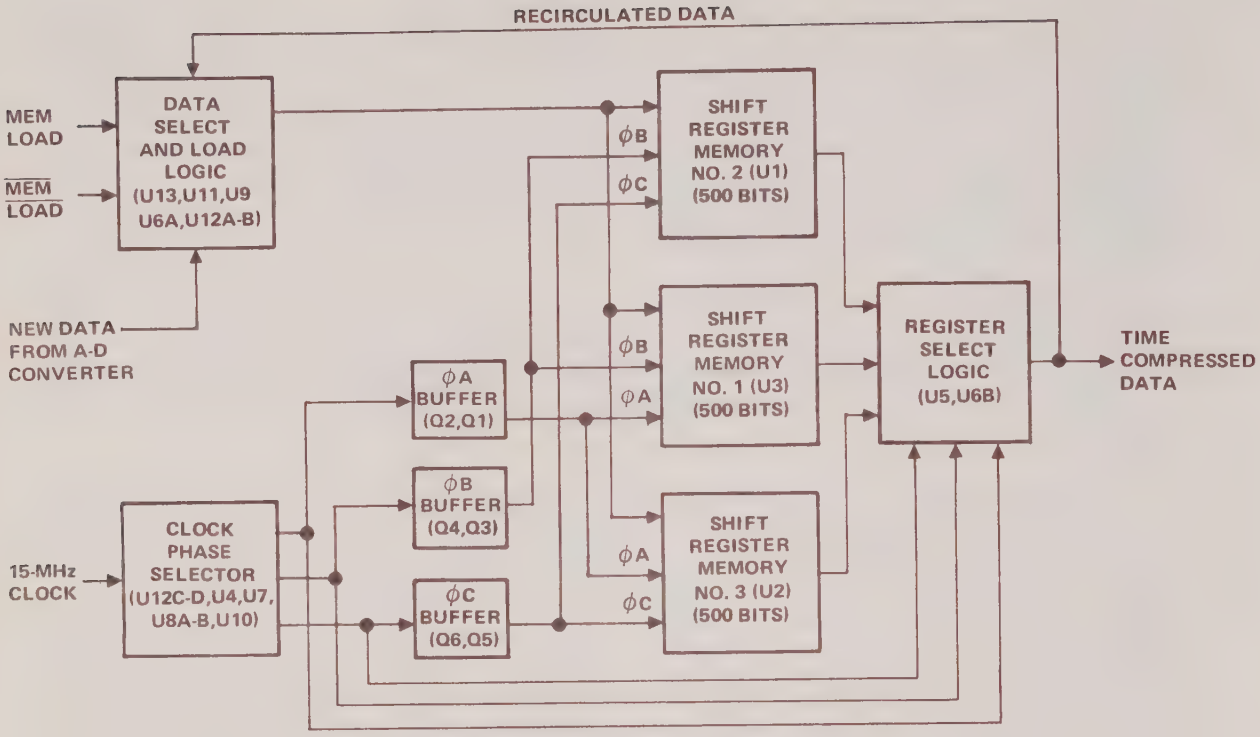


Figure 3-5. Block Diagram of Shift Register Memory "Delay Line"

To illustrate a typical example of time compression, assume operation in the 50 Hz RANGE. The sampling rate is 150 samples per second; that is, a sample is taken and digitized every 6.667 milliseconds. The first bit is applied, travels through the delay line, and is recirculated (fed back to the input again). The first bit recirculates 66 times; this requires 6,600 microseconds. The first bit travels two-thirds of the delay line path again (for the 67th time) when the second bit is available. To load the second bit immediately after the first bit (by 67 nanoseconds), the second bit is temporarily stored until the first bit emerges from the delay line. The first bit is then re-entered, and then the second bit is applied 67 nanoseconds behind the first bit.

Now these two bits recirculate and are joined by a third, fourth, fifth, etc. bit, each 67 nanoseconds apart, until over a period of 10 seconds, 1500 bits have been entered and are circulating. The time compression just described compresses an interval of 6.667 milliseconds between data samples to an interval of 67 nanoseconds between output data points, or a time compression ratio of 100,000 to 1.

Note that the time interval between the digitized samples in the memory is only a fraction of the time interval between samples of the analog input signal. In this example, the data samples taken at 150 samples per second are digitized and compressed into the delay line at 15 million bits per second. Thus a speed-up ratio of 100,000 is realized. Or in other words, by contracting the input signal's time base, a 50-Hz input signal is speeded up to 5 MHz.

The benefit realized from time compression (speeding up of the input signal frequency before analysis) is that the 50-Hz input of the previous example speeded up to 5 MHz can now be analyzed with an equivalent resolution in a fraction of the time. This permits processing the signal at a much faster rate; thus the input spectrum is scanned very fast making possible a real time analysis.

The outputs of the nine delay line memory units are parallel transferred to a high-speed digital-to-analog (D-A) converter (A1). Here a speeded-up waveform of the input signal is reconstructed in analog form for application to the analyzer section. The D-A converter accepts the digital words at the 15-MHz clock rate and produces a "box car" type of a waveform representation of the data samples in memory.

From the output of the high-speed D-A converter, the time-compressed analog signal, a speeded-up replica of the input signal, is routed to the analyzer section.

3.3.3 Analyzer (See Figure 3-6.)

The analyzer section scans the 10-kHz to 5-MHz time-compressed signal by mixing it with an 18-MHz to 23-MHz swept tuning signal that is incremented in 500 or 1000 intervals. The resultant 18-MHz up-converted I.F. signal is multiplied by a sine^2 time weighting signal and then filtered. Because the data record length is 100 microseconds, an I.F. filter with a 10-kHz bandwidth is used. After filtering, the 18-MHz I.F. signal is down-converted to 200 kHz and then detected to provide the LIN STEP, LIN, and LOG SPECTRUM OUTPUTS.

The time-compressed signal is applied to a summing network at the input of the scan unit (A27). If the front-panel FREQUENCY MARKERS switch is set to INT, an internally generated 500-kHz pulse signal from marker generator A18 is linearly combined with the time-compressed signal. (The marker generator comprises a 1-MHz crystal-controlled oscillator, a divide-by-two counter, and output gating.) The 500-kHz output pulse train, when summed with the time-compressed signal, produces 10 equally-spaced frequency marker "pips".

The output of the summing network is passed through a low-pass filter. This filter has a very high stop-band rejection and thereby passes only the 10-kHz to 5-MHz speeded-up data. The filtered signal is available at MEMORY OUTPUT connector J22; it is also applied to the up-converter (mixer).

The up-converter, a balanced modulator, combines the filtered analog time-compressed signal (and internal markers, if added) with the 18-MHz to 23-MHz tuning signal from the sweep oscillator. The balanced modulator leaves only the upper and lower sidebands; the lower sideband is used for its information content.

The up-converter output is combined in a multiplier circuit with a 100-kHz sine^2 signal. Therefore, the 18-MHz signal is caused to vary in amplitude from zero to maximum at a 10-kHz rate. This technique, called time-weighting, modifies the effective response of the analyzing filter, and effectively eliminates the spectra produced by the effects due to a finite record length in the memory.

Another benefit of time weighting is the improved selectivity of the narrow-band analyzing filter. This filter consists of a crystal resonator (at 18 MHz) having a single-degree-of-freedom response; that is, its response is that of a single-tuned circuit. Reduced analysis

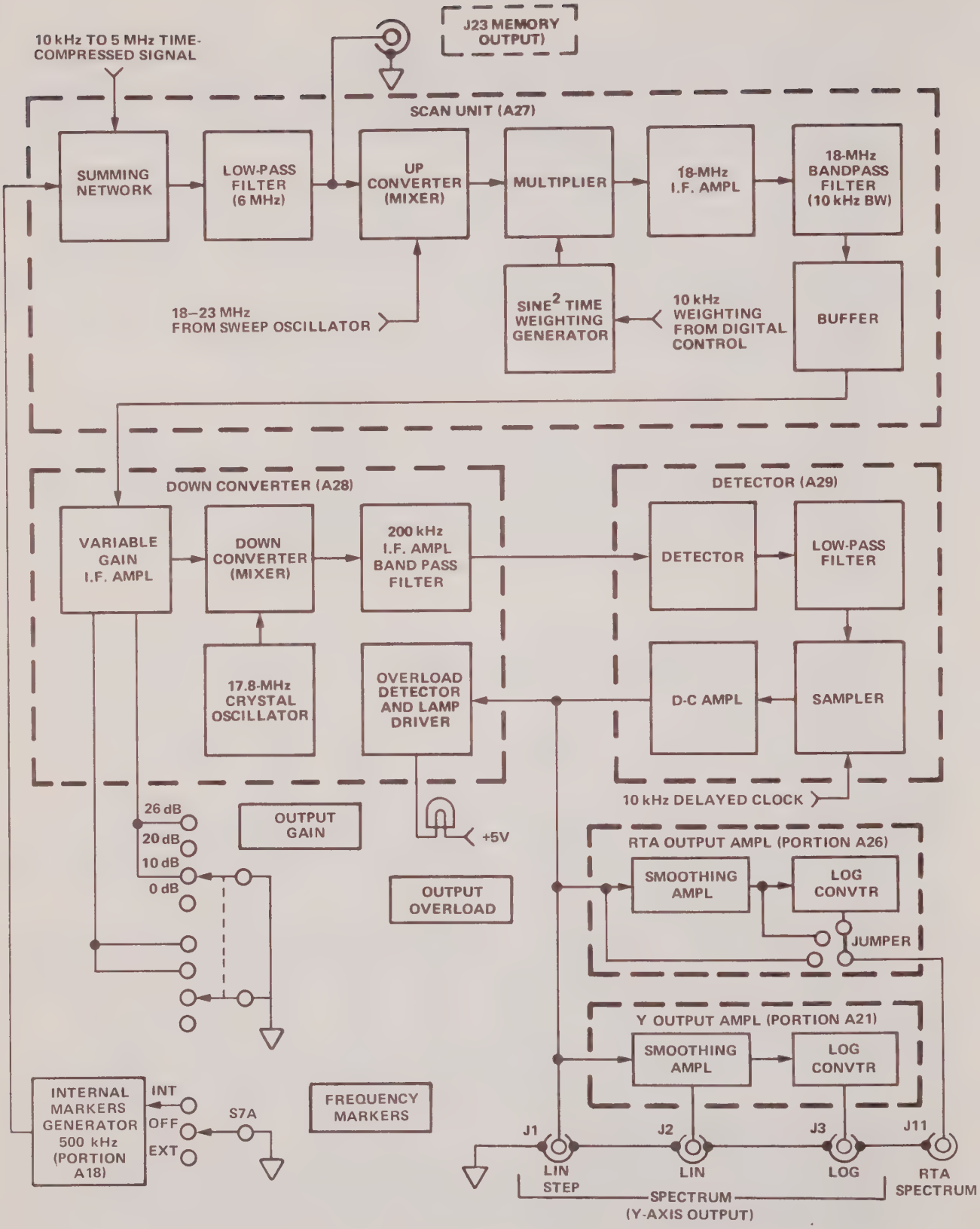


Figure 3-6. Functional Block Diagram of Analyzer Section

time and improved selectivity are achieved by using a time varying "gain control" ahead of the filter. The "gain control" is effected by controlling the 18-MHz signal with a $sine^2$ signal. Thus the input to the narrow-band filter is the product of the $sine^2$ time weighting signal and the 18-MHz signal that is carrying the same amplitude information as the analog input to the analyzer.

The time weighting modifies the spectrum of the narrow-band signal such that the filter asymptotic response has an attenuation improvement from 6 dB per octave to 18 dB per octave, and the center passband is about 1-1/2 times wider between the 3 dB bandwidth points. In this way the selectivity is improved without the use of a narrower band filter which would decrease the analysis rate. This improved response time makes possible real time analysis.

The 18-MHz filtered I.F. signal is buffered and routed to the down-converter (A28).

Preceding the down-converter mixer circuit, a variable gain amplifier provides fixed gains of 1, 3.16, 10, or 20 as selected by the front-panel OUTPUT GAIN switch. For all normal levels of periodic input signals, the GAIN switch should be set to 1 (0 dB). When analyzing a random type signal input such as white noise, because of the low energy content in the narrow-band samples taken from such a broad spectrum, additional gain can be inserted as required for a suitable output presentation.

The 18-MHz signal is mixed with a 17.8-MHz signal from a crystal-controlled oscillator. The 200-kHz difference frequency signal is selected by a 200-kHz bandpass filter. The bandwidth is approximately 175 kHz about the 200-kHz center frequency. The 200-kHz signal is buffered and fed to the detector card, A29.

A linear envelope detector is used to demodulate the 200-kHz I.F. signal. The detected signal is filtered to remove the 200-kHz carrier, and then sampled. Sampling is accomplished by passing the detected signal through a gate that is controlled by the 10-kHz clock signal. Thus, a sample is taken every 100 microseconds in synchronism with the time weighting function. Note that the d-c value (0 to 5V) of each step is proportional to the sampled spectrum signal amplitude of the synthesized filter location.

The samples are amplified and routed to the output overload detector on A28, to the RTA LIN STEP output connector J12 on the rear chassis, and to the X and Y output amplifier, A21. The overload detector is adjusted to cause the front-panel OUTPUT OVERLOAD indicator to flash if the level of the d-c samples exceeds 5V.

The X and Y output amplifier (A21), contains two identical amplifier and log converter circuits, one for the SPECTRUM LIN and LOG outputs and one for the FREQUENCY LIN and LOG outputs. The SPECTRUM channel is described here: The d-c samples from the detector are routed through the normally closed contacts of a relay to SPECTRUM LIN STEP output connector J1 and to a d-c smoothing amplifier. The relay facilitates selection of an external input, specifically the output of an SD302 Ensemble Averager when interconnected with the SD301B. The output of the d-c smoothing amplifier provides the SPECTRUM LIN output (0 to 5V); it is also fed to the log converter circuit. The log converter circuit provides a 1V log output that is proportional to the log of the LIN output; it is routed to the SPECTRUM LOG output connectors. An optional output amplifier assembly (NO. 11430-3) also contains a squaring circuit that provides a d-c output equal to the square of the Y-axis spectrum data.

The sampled spectrum signal at A29-17 is also routed to A26-6. On circuit card A26 is located an amplifier and log converter circuit that is similar to the SPECTRUM channel on circuit card A21. (See Figure 5-9, Mixer.) The RTA output signal at A26-7 is routed to rear-chassis connector J11, RTA SPECTRUM. Although normally jumpered as shown on Figure 5-9 to provide SPECTRUM LOG output, the jumper can be changed to provide SPECTRUM LIN STEP or LIN. This output is useful for "looking" directly at the RTA signal when using an external averager, such as the SD302 series Ensemble Averager.

3.3.4 Sweep Oscillator (See Figure 3-7.)

The sweep oscillator section generates the 18- to 23-MHz linearly stepped tuning signal (in increments of 10 kHz or 5 kHz) for use by the up-converter in the scan unit of the analyzer section. This function is performed by the 18–23 MHz VCO. An additional function of this section is to supply the FREQUENCY LIN STEP, LIN, and LOG outputs that are used for driving the X-axis of a display oscilloscope or recorder. The 18–23 MHz VCO is described first.

See the upper portion of Figure 3-7. The 18–23 MHz VCO consists of a voltage-controlled variable frequency LC oscillator, a charge-dump FVC (frequency-to-voltage converter), a constant-area FVC, a divide-by-16 counter, a divide-by-100 counter, and 2 operational amplifiers.

A voltage-variable capacitor is the frequency controlling element of the LC oscillator. As the 500 or 1000 voltage steps (increasing in value from 0V to 5V) from the BCD ladder are applied to the VCO, the output frequency is incremented from 18 to 23 MHz. This signal is divided by 16 to provide 1.125 to 1.438 MHz which is applied to the charge-dump FVC. The purpose of the charge-dump FVC is to linearize the frequency-versus-control-voltage-input characteristics of the LC oscillator.

In Figure 3-7, the charge-dump FVC is depicted functionally as a single-pole double-throw electronic switch. The switching rate is controlled by the output frequency (divided by 16) of the LC oscillator. The action of the switch alternately charges capacitor C1 to the voltage (–V) and discharges it into the summing junction at the input of the operational amplifier that precedes the VCO. Because the charge in C1 is transferred once each period of the divided-down VCO output frequency, the net current flow is proportional to the VCO output frequency. The operational amplifier compares this current with the net current flowing through R_{S1} and R_{Z1}, and drives the LC oscillator to a frequency which causes these currents to balance.

The purpose of the constant area FVC is to compensate for any frequency drift in the charge-dump FVC (normally due to temperature changes). The constant area FVC is not affected by temperature variations because it derives its conversion from the 2 MHz crystal controlled clock pulses and a Zener reference diode voltage source. The constant-area FVC comprises the circuitry in the lower portion of the 18–23 MHz VCO in Figure 3-7; i.e., the divide-by-100,

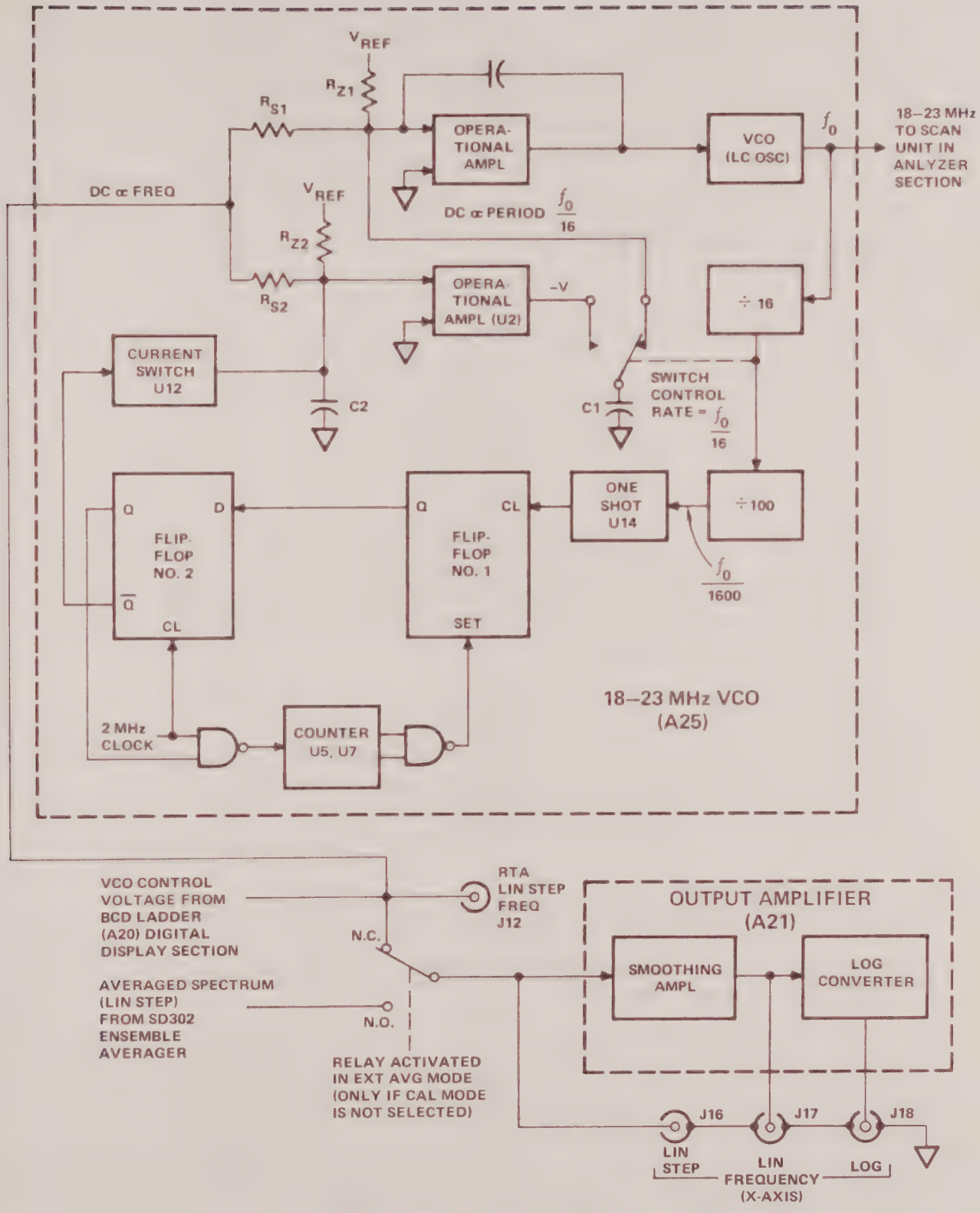
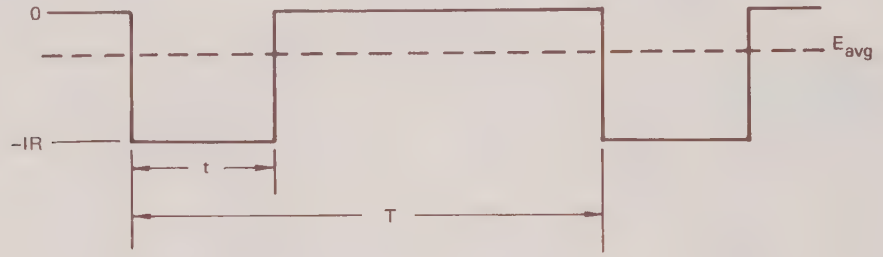


Figure 3-7. Functional Block Diagram of Sweep Oscillator Section

one-shot (U14), flip-flops 1 and 2, counter (U5, U7), etc. The constant-area FVC performs frequency to voltage conversion by generating a current pulse of constant ampere-second area, once each cycle of its input frequency. This current pulse is filtered by capacitor C2 and passed through a resistor (equivalent to the parallel value of R_{S2} and R_{Z2}) to generate a voltage proportional to frequency. As shown in the waveform below, a negative pulse of amplitude –IR and width t occurs once each input period T (T equals the VCO frequency period times 1600). The average output voltage $E_{avg} = -IR(t/T) = -IRtf_0$; hence, the average voltage output is proportional to the input frequency.



The constant area pulse is generated by counting 90 2-MHz clock pulses. The divided-down VCO output frequency, $f_0/1600$, triggers one-shot U14 which in turn resets F–F No. 1. The "Q" output of F–F No. 1 raises the "D-line" input of F–F No. 2, allowing it be set by the next 2-MHz clock pulse. With F–F No. 2 set, its"Q" output enables the NAND gate at the counter input to pass 2-MHz clock pulses.

After 90 clock pulses are counted, an output from the counter sets F–F No. 1. This action lowers the "D-line" input to F–F No. 2, allowing it to be reset by the next 2-MHz clock pulse. The "$\overline{Q}$" output of F–F No. 2 turns on the current switch, U12. The output of the current switch is compared with the net current flowing through R_{S2} and R_{Z2} (see Figure 3-7) at the input of operational amplifier U2. U2 amplifies any difference by 100,000 and produces an output of –5V. This voltage is further amplified to provide the charge voltage for the dump charge FVC.

The VCO control voltage steps are also routed to the RTA LIN STEP FREQ rear-chassis connector, J12. Also, in all modes except EXT AVGR, this signal is routed to rear-chassis connector J16, LIN STEP, and to the frequency channel on the output amplifier card (A21). (See the lower portion of Figure 3-7.)

Here a smoothing amplifier provides the FREQUENCY LIN output (0 to 5V), and a log converter provides a 1V d-c FREQUENCY LOG output that is proportional to the log of the FREQUENCY LIN output. The LIN and LOG outputs are available at both front-panel and rear-chassis connectors for application to the X-axis of external recording equipment.

Note that when the SD302 is used and the SD301C is in EXT AVGR mode, the internally generated LIN STEP signal is available at J12. However, the outputs at J16, J17, and J18 are derived from the averaged spectrum lin step signal from the SD302.

NOTE

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to facilitate better manual arrangement.

3.3.5 Digital Control (See Figure 3-8.)

The digital control section performs various functions as selected by the front-panel switches and controlled by either internally or externally applied control signals. The control functions are generated by the selected gating logic, which, in turn, operate as electronic switches or latches to pass or hold control levels and/or signals to applicable circuits in the various sections of the instrument. The use of gating logic facilitates application of external control signals (normally a 5V pulse) to perform the same function as the front-panel switch.

The digital control section comprises the following circuit cards: display control (A16), marker generator (A18), counter control (A17), counter (A19), and BCD ladder (A20).

The display control card (A16) contains three flip-flops that determine the MEMORY modes of operation: HOLD, UPDATE, and TRANSIENT CAPTURE. The two states of the first flip-flop are HOLD and UPDATE. The states of the other two flip-flops are: in transient capture mode, WAIT and CAPTURE; when not in transient capture mode, the flip-flops are reset. The output of the first flip-flop is the "clock update" signal; this signal determines whether or not data is loaded. When transient capture mode is initiated, the "wait" flip-flop is set; this output enables a gate at the set input to the "capture" flip-flop. When a transient trigger triggers this gate, the "capture" flip-flop is set and a transient capture cycle is initiated; this cycle is terminated automatically when the "hold" flip-flop is set. For example, the MEMORY TRANSIENT CAPTURE mode is manually activated by pressing the front-panel TRANSIENT CAPTURE push button. Then, with the TRANSIENT TRIGGER switch set to INT (see card A18), transient capture is initiated as a function of the level of the conditioned band-limited input signal from the buffer (on card A32). In EXT mode, transient capture can be initiated by application of a trigger pulse (1V at 2 microseconds duration) applied to TRIG INPUT connector J9 on the rear chassis. Note that if the front-panel DIGITAL LOCATER switch is not set to TRANSIENT CAPTURE, the transient capture mode loads 1500 data points into the memory. If the switch is set to TRANSIENT CAPTURE, the number of samples to be loaded is determined by the value of the % FULL SCALE switch. (See marker generator card A18 on Figure 3-8.) The comparator senses when the count matches the number in the % FULL SCALE switch and sends an "end transient" pulse to the display control card to activate the hold mode.

The internally generated frequency markers are supplied by marker generator card A18; this portion of the card is shown in Figure 3-6. Also on circuit card A18 is the sweep rate feedback control circuitry; it senses the SPECTRUM LIN STEP output, and if a large variation occurs in amplitude, the circuit develops a logic level that slows the sweep (PLOTTER MODE only).

The counter control card (A17) provides the sweep start/stop signal which allows pen lift, generates unblanking (output at J19), and supplies an oscilloscope trigger (output at J20). (The pen lift, unblanking, and scope trigger output driver circuits are on circuit card A16.) These

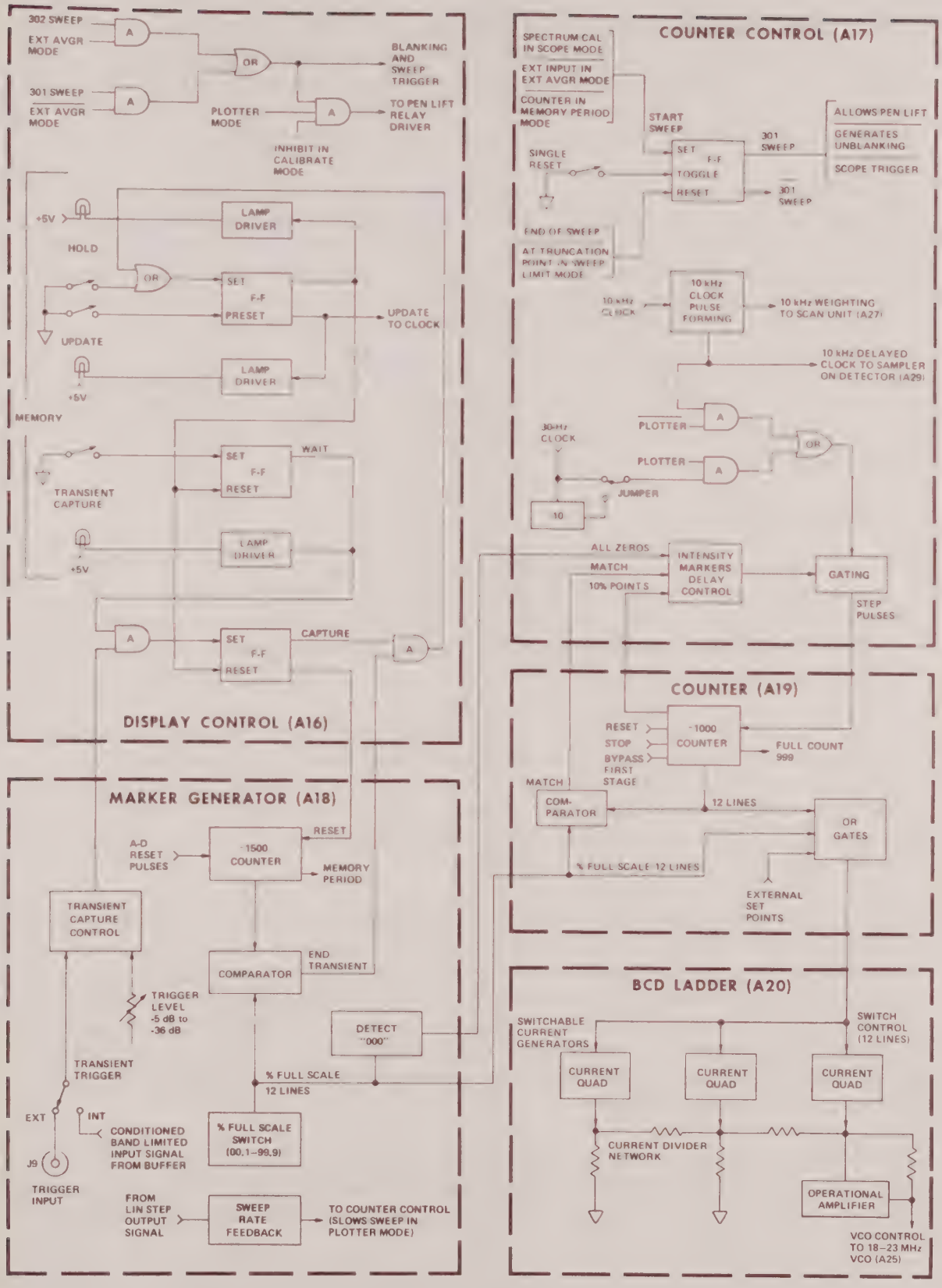


Figure 3-8. Functional Block Diagram Digital Control Section

outputs are generated as a function of the start-sweep signal applied to the "301 flip-flop" set input. The end-of-sweep is generated at the truncation point in the sweep limit mode. The SINGLE RESET push button toggles the flip-flop thereby starting the sweep from a reset condition, or stopping the sweep if it is sweeping. Also on the counter control card is the 10-kHz inverter circuit that feeds the 10-kHz weighting circuit in the scan unit (A27).

As in the previously described time compression and analyzer sections, the overall operation of the sweep oscillator section is also synchronized to the internal clock frequencies. (See circuit card A17 in Figure 3-8.) The 10-kHz clock (or the 30-Hz clock in PLOTTER MODE) is gated through as step pulses under control of the intensity markers delay control logic. When the DIGITAL LOCATER is set to INTENSITY MARKER, an intensity marker is present when the ÷1000 counter matches the value of the % FULL SCALE switch setting, except when this switch is set to all zeroes (000). Then the 10% points are intensified. The ÷1000 counter is located on counter circuit card A19. It counts the 10-kHz step pulses. Its output (in binary coded decimal format) is gated through an OR gate and converted to a proportional analog voltage by BCD ladder card (A20). This d-c voltage is fed to the 18–23 MHz VCO (A25) for use as the VCO frequency control voltage.

3.3.6 Clock (See Figure 3-9.)

The clock generates the timing signals that synchronize all internal operations. A 14.980-MHz crystal-controlled oscillator provides the basic clock frequency for the high-speed D-A converter (A1) and memory units (A3 through A11). For sake of simplicity, here and on all drawings, the 14.980-MHz frequency is referred to as 15 MHz; therefore all subdivisional frequencies become whole numbers such as 3 MHz, 60 kHz, 30 kHz, etc.

To ensure the overall synchronization of all timing functions, resynchronizing circuits are used. To compensate for counter delays, the sampling frequency, although divided down from the 15-MHz clock, is resynchronized before being routed to the A/D converter. (See logic elements A2A25 and A2A22 in Figure 3-9.) Also the 3-MHz clock, also derived from the 15-MHz clock, is resynchronized and, in turn, is used to synchronize the divided-down 10-kHz clock. (See logic element A2A5 in Figure 3-9.)

The 3-MHz clock is divided by 10 to produce 300 kHz, and then further divided by a series of divide-by 5 and divide-by 2 flip-flop circuits to produce the sampling frequencies. Each sampling frequency is applied to a gate that is controlled by the front-panel ANALYSIS RANGE switch. As each RANGE is selected, the proper gate is enabled allowing resynchronization of the correct sampling frequency signal. As previously described in the time compression section, the sampling frequency is always three times the RANGE UPPER LIMIT frequency. For example, with the ANALYSIS RANGE switch set to 10K UPPER LIMIT (Hz), the 30-kHz signal is gated through for use as the sampling frequency.

The 15-MHz clock is also divided by 1500 to produce the 10-kHz clock. After synchronization by the 3-MHz clock signal, the 10-kHz clock is routed to all applicable points. The memory load logic, fed by the 10-kHz clock, supplies the control signals for loading the memory units in the time-compression section.

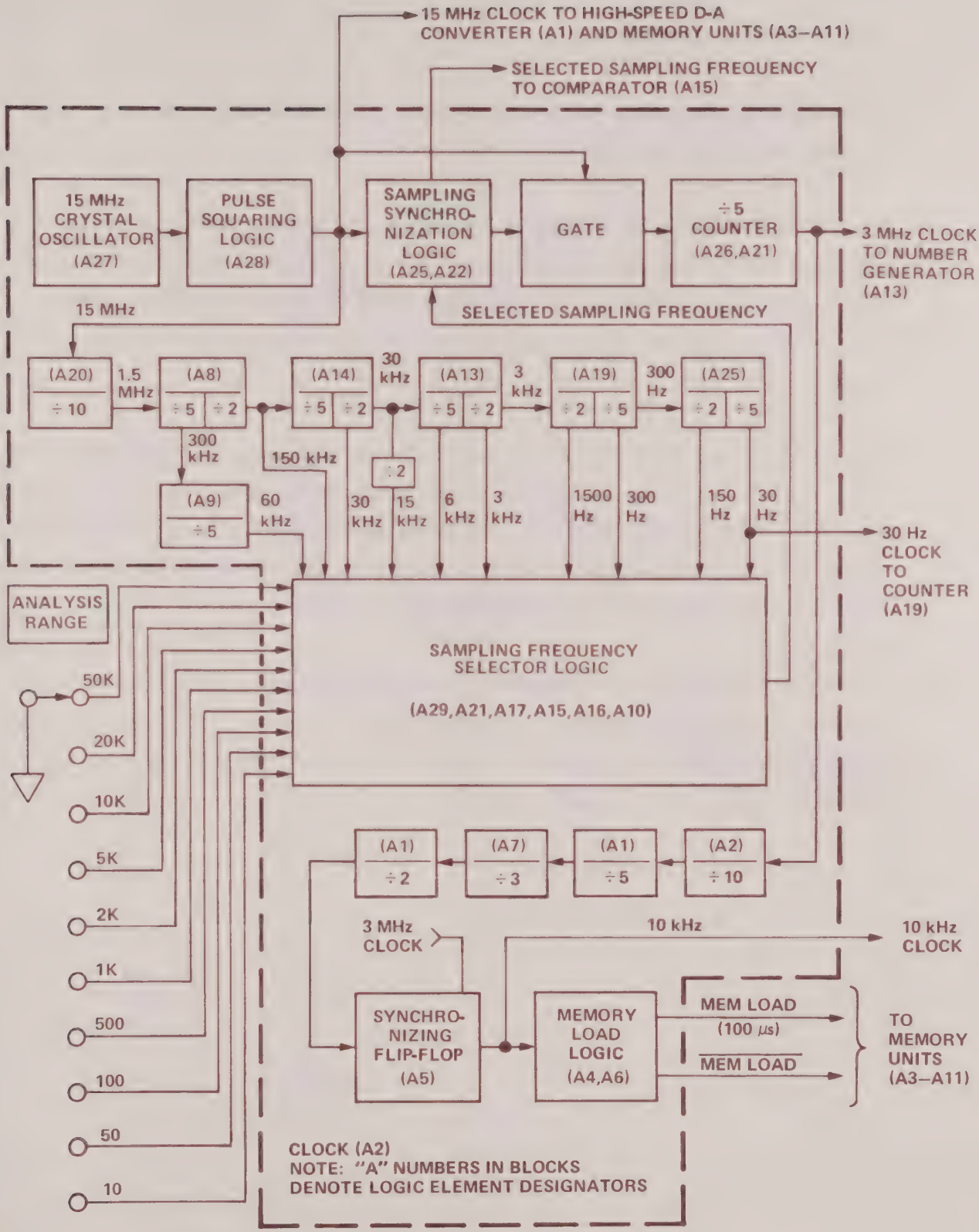


Figure 3-9. Functional Block Diagram of Clock Section

3.3.7 Power Supply (See Figure 3-10.)

Conventional solid-state diode rectifiers and electronic voltage regulators are used to provide all circuit d-c operating voltages: +28V, +12V, +5V, and -12V.

The 115/230V, 50-400 Hz a-c input power is fused and filtered, and routed through the front-panel POWER push button switch to power transformer T1. The rear-chassis 115/230 slide switch facilitates connecting the primary windings of T1 in parallel for 115V operation or in series for 230V operation. The multiple secondary windings of T1 supply the full-wave diode rectifier circuits.

The +28V is derived from a +45 unregulated source, and is referenced by a zener diode. The +12V and +5V regulators are referenced to the -12V supply which is referenced to a zener diode. Because the +12V and -12V supplies are used extensively by operational amplifier circuits, the amplitude of the +12V regulated output is caused to track the -12V supply; that is, although opposite in polarity, both the -12V and +12V are always equal in amplitude.

The +5V supply, used mainly by integrated circuit elements, employs an SCR "crowbar" circuit to prevent an overvoltage condition. If the voltage tries to rise above +5V, the overvoltage sense circuit drives the SCR into conduction. The SCR in turn shorts the unregulated 12 volts to ground, thus causing the fuse to open the circuit.

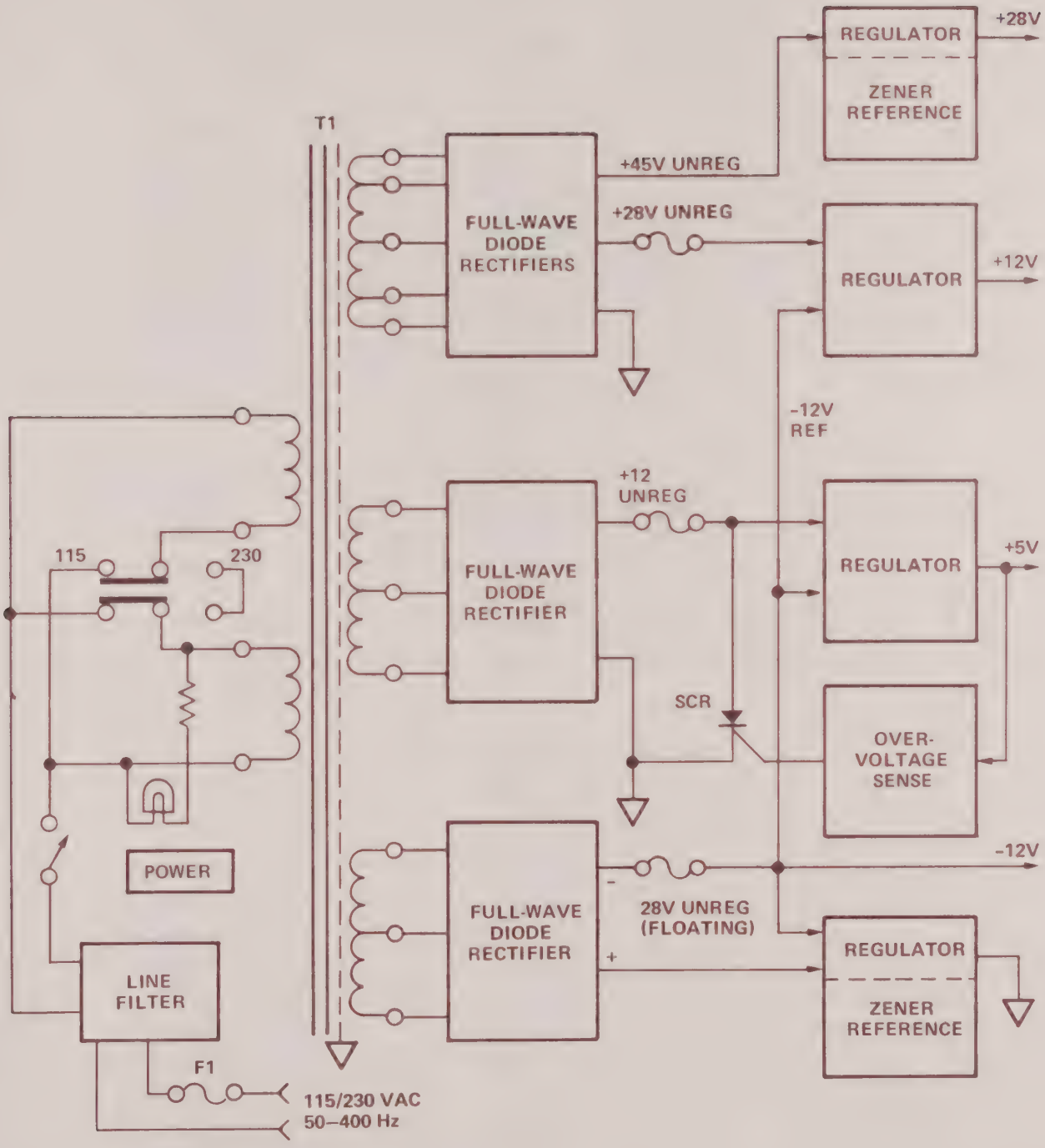


Figure 3-10. Functional Block Diagram of Power Supply

SECTION IV

CALIBRATION

4.1 GENERAL

Before calibrating the instrument, the technician is advised to study carefully Section III of this manual. Refer also to Paragraphs 1.3, Front Panel Functional Description, and 1.4, Rear Chassis Functional Description, in Section I of this manual. Easy access to all calibration controls is facilitated by use of the extender card. The controls can then be found by referring to the component layout drawings included with the schematic drawings in Section V of this manual. Most voltage checks and adjustments can be made with the cards installed. Remove cards only when directed, and then use caution when installing extender and circuit card; be sure to remove power. Figure 4-1 is a top view of the instrument showing the location of the circuit cards.

Throughout the calibration procedure, calibration controls are referenced by their circuit card and part number alphanumeric designators. For example, on the current generator circuit card (A22), gain control R19 is referred to as A22R19. Circuit card pin connections are referenced by the circuit card alphanumeric designator, hyphen, pin number/letter; such as A20-7 or A3-D.

Table 4-1 lists the test equipment required to calibrate the SD301C; test equipment having equal or better operating characteristics may be substituted. The Model SD35-1 Ladder Test Fixture is available only from Spectral Dynamics Corporation.

Table 4-1. Test Equipment Required

Name	Model No.	Manufacturer
AC Voltmeter	3400A	Hewlett-Packard
Digital Voltmeter	3400A	Hewlett-Packard
Oscilloscope	454	Tektronix
Oscillator	4200	Krohn-Hite
Frequency Counter	5223L	Hewlett-Packard
Ladder Test Fixture	SD35-1	Spectral Dynamics
Display Oscilloscope	143A	Hewlett-Packard
*Frequency Counter	1191	General Radio
*RF Voltmeter	91BA	Boonton
*Frequency Synthesizer	1164-A3	General Radio
*8-inch Coaxial Cable with Fittings	Burndy: RSMDEX-1 and RMDXK-1 insert RSCDEX-1 and RCDXK-1 insert	

*Not required unless the Comprehensive Calibration procedure of Paragraph 4.3 is performed.

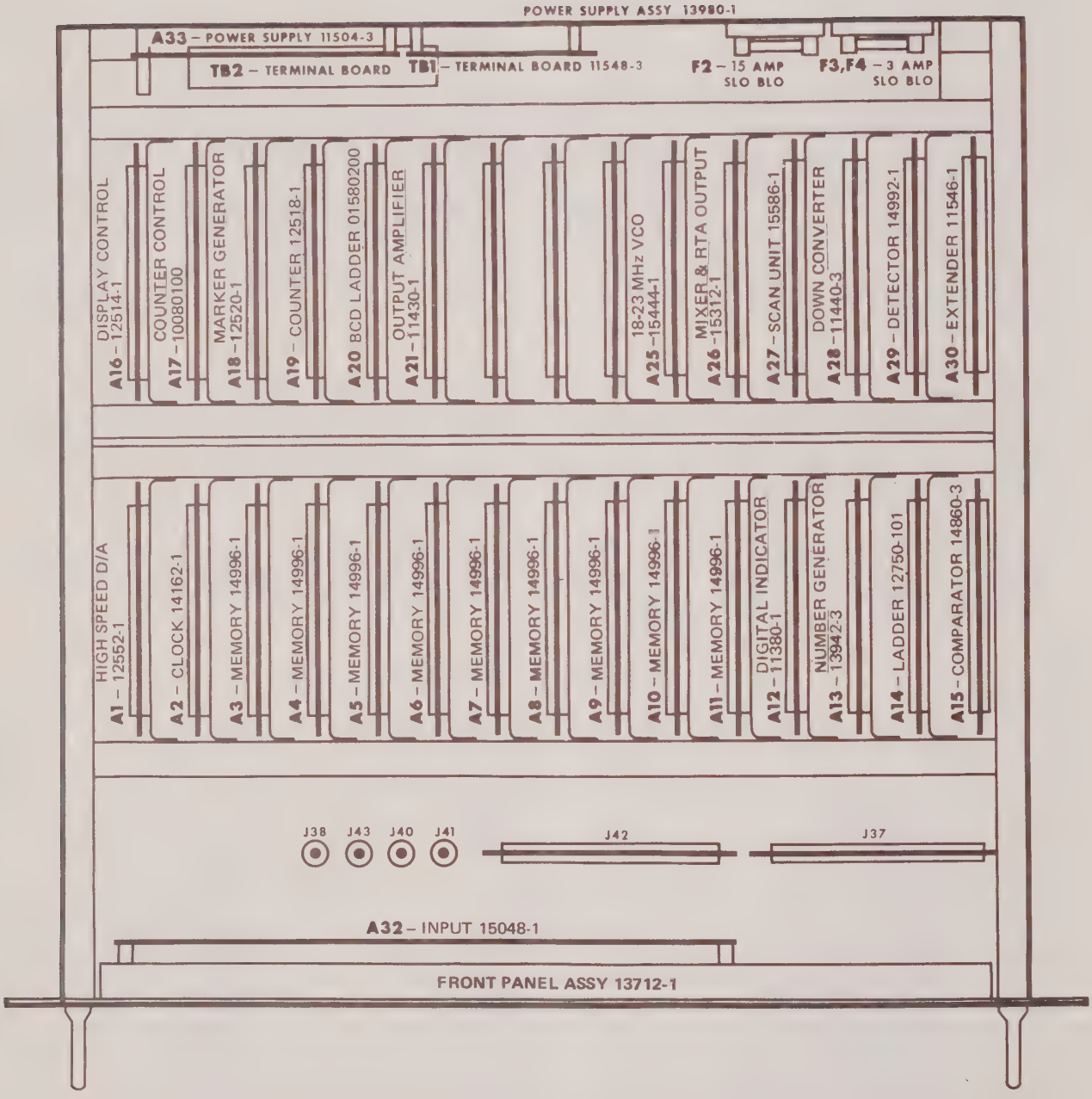
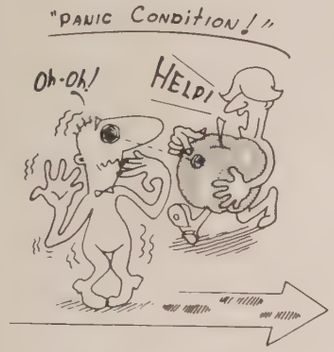

POWER SUPPLY ASSY 13980-1
A33 – POWER SUPPLY 11504-3
TB2 – TERMINAL BOARD
TB1 – TERMINAL BOARD 11548-3
F2 – 15 AMP SLO BLO
F3,F4 – 3 AMP SLO BLO
A16 – DISPLAY CONTROL 12514-1
A17 – COUNTER CONTROL 10080100
A18 – MARKER GENERATOR 12520-1
A19 – COUNTER 12518-1
A20 BCD LADDER 01580200
A21 – OUTPUT AMPLIFIER 11430-1
A25 – 18-23 MHz VCO 15444-1
A26 – MIXER & RTA OUTPUT 15312-1
A27 – SCAN UNIT 15586-1
A28 – DOWN CONVERTER 11440-3
A29 – DETECTOR 14992-1
A30 – EXTENDER 11546-1
A1 – HIGH SPEED D/A 12552-1
A2 – CLOCK 14162-1
A3 – MEMORY 14996-1
A4 – MEMORY 14996-1
A5 – MEMORY 14996-1
A6 – MEMORY 14996-1
A7 – MEMORY 14996-1
A8 – MEMORY 14996-1
A9 – MEMORY 14996-1
A10 – MEMORY 14996-1
A11 – MEMORY 14996-1
A12 – DIGITAL INDICATOR 11380-1
A13 – NUMBER GENERATOR 13942-3
A14 – LADDER 12750-101
A15 – COMPARATOR 14860-3
J38
J43
J40
J41
J42
J37
A32 – INPUT 15048-1
FRONT PANEL ASSY 13712-1

Figure 4-1. Chassis Top View

TROUBLESHOOTING ON EASY ST.



PANIC THOUGHTS

- I've never seen this one before!
- Does anybody know how it happened?
- They probably need it fixed yesterday!
- Who can I ask for help?

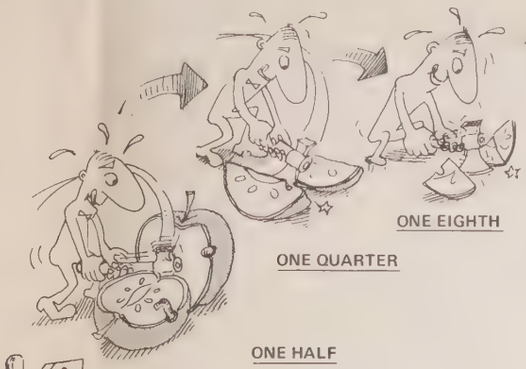
POSITIVE APPROACH

- Problem is probably simple.
- I can fix this problem easily.
- I am going to think logically.
- I am going to carefully evaluate the front panel indications.
- I'll talk to the person who had the problem.

READY

- I can whip the problem NOW.

SUCCESSIVE HALF-SPLIT TROUBLESHOOTING METHOD



ONE QUARTER

ONE EIGHTH

ONE SIXTEENTH

ONE HALF

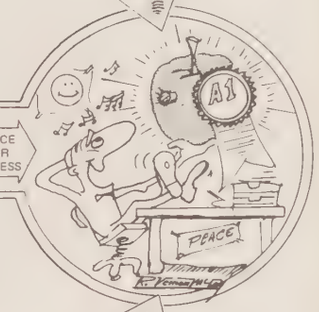
- Evaluate front panel symptoms before removing cover.
- Look for obvious—simple problem.
- Do not adjust to "FIX" problems!

"ONE FOUND"

- Have spare parts or circuit card?
- Check & Double-check; then order parts.
- Prepare for call:
  Have correct part number from part or schematic.
  Have complete Model and Serial Numbers from rear of chassis.

The SDC Customer Service Team is At Your Service Aiming To Please

SERVICE IS OUR BUSINESS

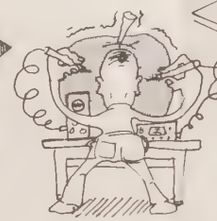


PREPARATION FOR CALL

- Have talked to person who experienced the problem.
- Have read the manual.
- Have complete Model and Serial Numbers from rear of chassis.

YOU CALL FOR INSTRUCTIONS

- We spell out tests.



YOU PERFORM CHECKOUT

- As instructed

WE CALL BACK

- To Check & Double-check

4.2 CALIBRATION PROCEDURE

NOTES

1) Before starting, it is recommended that the technician read through the entire procedure.

2) To perform the calibration, the instrument must be operative. If not, the problem must first be isolated and repaired before other sections can be calibrated.

CAUTIONS

1) To ensure proper calibration of the instrument, the following calibration procedure must be performed in its entirety and in the sequence listed.

2) To prevent permanent damage to the pen-lift relay contacts in the SD301C, be sure that a diode is installed across the pen-lift solenoid coil in the recorder being used.

a. Remove the top cover. Remove the ladder card (A14), the BCD ladder (A20), and the high-speed D/A (A1). Apply power to the instrument and allow at least 30 minutes for warmup.

b. Calibrate the ladder cards (A1, A14 and A20) using the Model SD35-1 Ladder Test Fixture; this can be done while the instrument is warming up. Use the calibration procedure included with the Model SD35-1 Ladder Test Fixture.

c. Remove power from the SD301C and re-install cards (A1), (A14) and (A20). Re-apply power and proceed as follows:

d. Set front-panel controls as follows:

INPUT RANGE (Vrms)	
Coarse Switch	1
Fine Switch	0/CAL
FREQUENCY MARKERS Switch	OFF
MEMORY UPDATE Switch/Indicator	Lighted
ANALYSIS RANGE Switch	2 kHz
OUTPUT GAIN	X1
OUTPUT OPER/CAL Switch	OPER
OUTPUT MODE Switch	SCOPE FAST
Sweep Initiation Switch	AUTO
DIGITAL LOCATER	OFF

e. Connect the SPECTRUM LIN OUTPUT to the vertical input and the FREQUENCY LIN OUTPUT to the horizontal input of an oscilloscope (Hewlett-Packard 143A or equivalent). Calibrate the oscilloscope to the SD301C outputs. (Refer to Section II of this manual.)

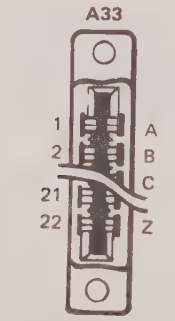
4.2.2 Power Supply (A33)

Monitor the power supply voltages at the top of the extender card with the card inserted into its chassis receptacle.

CAUTION

To prevent possible shorting of voltages and damage to the power supply, use a thin screwdriver having an insulated shaft to make the following adjustments.

Connect DVM (digital voltmeter) (Hewlett-Packard Model 3440A or equivalent) to each of the following pins of the extender card and adjust the associated control for the proper voltage. Check also for ripple voltage at each pin listed below.



TOP VIEW OF EXTENDER CARD (FROM FRONT)

Pin No.	Voltage	Adjust	Max. Ripple (mV p-p)
2	+28V ±10 mV	A33R15	20
22	−12V ±10 mV	A33R2	20
1	+12V ±10 mV	A33R5	20
21	+4.9V ±10 mV	A33R8	40

4.2.3 Input D-C Levels

NOTE

Do not perform this procedure unless the input circuitry on input card A32 has just been serviced, or it is not operating properly.

a. Set INPUT RANGE (Vrms) switch to 10, and FREQUENCY MARKERS switch to OFF.

b. Connect DVM to A32TP5 (input card on front-panel assembly), and adjust A32R5 for zero volts ±10 mV.

c. Connect DVM to A32TP6 and adjust A32R53 for zero volts ±10 mV.

d. Connect DVM to A15TP1 (comparator card) and adjust A15R4 for 2.415 Vdc (2.410 to 2.420 Vdc).

4.2.4 Input Filter

Optimize the gain and frequency response characteristics of the input (active) filter as follows:

a. Ensure that the test oscillator at SIGNAL INPUT (J24) is supplying 1 Vrms ±5 mVrms at 600 Hz.

b. Observe the INPUT NORMAL indicator and adjust A32R63 until lamp is extinguished.

c. Now turn A32R63 in the opposite direction until the INPUT NORMAL indicator just lights; then continue turning A32R63 an additional one-half turn.

d. Using a-c voltmeter, measure and note the dB level at A15TP2.

e. Increase frequency of the test oscillator for maximum reading on a-c voltmeter. (Frequency will be approximately 2.1 kHz.)

f. Adjust A32C28 and/or A32C42 so a-c voltage at A15TP2 is 0.2 dB ±0.05 dB more than noted in Step d.

4.2.5 Clock (A2) Oscillator Frequency

a. Set the ANALYSIS RANGE switch to 50K.

b. Use a frequency counter (Hewlett-Packard 5223L or equivalent) and verify that the frequency at A2TP3 (clock card) is between 149.80 and 149.81 kHz. If not, adjust A2C1.

c. Set the ANALYSIS RANGE switch to 2K.

4.2.6 Output Amplifier (A21)

In this procedure, the FREQUENCY and SPECTRUM output log converters are adjusted to provide a 1V full-scale output and a 40 dB dynamic range.

NOTES

Do not perform this procedure unless X-axis or Y-axis linearity problems are apparent between 0 dB and –30 dB. If problems only exist at –40 dB, this will be corrected in the Final Adjustments.

If an Output Amplifier Assembly No. 11430-1 is installed, perform Steps a. through c. If Assembly No. 11430-3 is installed, perform Steps a. through e.

a. Remove power, remove the detector card (A29) and set aside. Extend the output amplifier (A21), connect a jumper wire from A21TP1 to A21TP9 and re-apply power. Adjust A21R48 (CLAMP) fully counter-clockwise.

b. Calibrate the FREQUENCY LOG output from the FREQUENCY-CAL positions (as checked in Paragraph 4.2.6) as follows:

1) Set OPER/CAL switch to FREQUENCY-CAL FULL SCALE and connect the DVM to the FREQUENCY LOG output. Record the DVM reading.

2) Set OPER/CAL switch to FREQUENCY-CAL –1 DECADE; DVM reading should decrease 400 mV ±10 mV from Step 1). Adjust A21R54, if necessary, for a step of 400 mV.

3) Set OPER/CAL switch to FREQUENCY-CAL FULL SCALE; DVM should read 1V ±5 mV. Adjust A21R24 if necessary.

4) Repeat Steps 2) and 3), as necessary.

5) Set the OPER/CAL switch to FREQUENCY-CAL –2 DECADES. DVM should read 200 mV ±10 mV; if not, adjust A21R8. If A21R8 is adjusted, Steps 2) through 4) must be repeated, then Step 5), as necessary.

c. The jumper wire added in Step a. connects the FREQUENCY-CAL points to the SPECTRUM output. Calibrate the SPECTRUM LOG (RTA SPECTRUM) output from the FREQUENCY-CAL points as follows:

1) Set OPER/CAL switch to FREQUENCY-CAL FULL SCALE and connect the DVM to the SPECTRUM LOG, J3, (RTA SPECTRUM, J11) output. Record the DVM reading for adjustment in next step.

2) Set OPER/CAL switch to FREQUENCY-CAL –1 DECADE; DVM reading should decrease 400 mV ±10 mV from Step 1). Adjust A21R55 (A26R22), if necessary, for a step of 400 mV.

3) Set OPER/CAL switch to FREQUENCY-CAL FULL SCALE; DVM should read 1V ±5 mV. Adjust A21R28 (A26R25) if necessary.

4) Repeat Steps 2) and 3), as necessary.

5) Set the OPER/CAL switch to FREQUENCY-CAL –2 DECADES. DVM should read 200 mV ±10 mV; if necessary, adjust A21R11 (A26R17). If A21R11 (A26R17) is adjusted, Steps 2) through 4) must be repeated, then Step 5), as necessary.

NOTE

The following Steps d. and e. are for Assembly No. 11430-3 only.

d. Connect DVM to A21TP10, set OPER/CAL switch to FREQUENCY-CAL FULL SCALE, and adjust A21R61 for 3.5V ±50 mV.

e. Connect DVM to A21TP15, and adjust A21R77 for 4.9V ±50 mV.

f. Remove power, replace A21 (do not remove jumper at TP1 and TP9). Extend A26 in place, and re-apply power. Turn A26R2 (CLAMP) fully CCW. (It will be adjusted later in Paragraph 4.2.16.)

g. Perform Steps c., 1) through 5); then replace A26. Remove jumper between A21TP1 and A21TP9.

4.2.7 Voltage Controlled Oscillator (A25)

a. Place FREQUENCY MARKERS switch to INT.

b. Place MEMORY PERIOD switch to AUTO.

c. Place DIGITAL LOCATER switch to INTENSITY MARKER.

d. Place SPECTRUM-CAL/FREQUENCY-CAL switch to OPER.

e. Adjust front panel Frequency Offset (located next to FREQUENCY-CAL) until the intensity dot appears on top of the first frequency marker.

f. Adjust A25R1 until the intensity dot appears on top of the tenth marker.

g. Repeat Steps e. and f. until the dots appear on top of the first and tenth frequency markers.

h. Place MEMORY PERIOD switch to MEMORY PERIOD. Set ANALYSIS RANGE switch to 2K.

i. Adjust A25R2 until most (or all) intensity dots appear on top of the frequency markers.

j. Repeat Steps b., e. and f.

k. Repeat Steps h. and i.

l. Place SPECTRUM-CAL/FREQUENCY-CAL switch to SPECTRUM-CAL 0 dB. The full scale calibrate signal should appear at 30% of full scale.

NOTE

Perform Steps m. and n. only if a Spectrum Translator is to be used with the SD301C.

m. Ground J15-18 (rear of chassis). Full scale spectrum calibrate signal should move to the left, from 30% of full scale to 20% of full scale.

n. If the intensity dot does not appear on top of the spectrum calibrate signal at the 20% point, adjust A25R15 for this condition.

4.2.8 Detector (A29)

a. Remove power, extend detector card (A29) in the extender card receptacle.

b. Connect DVM to A29TP1, and adjust A29R32 for 0V ±2 mV.

c. Connect DVM to A29TP2, and adjust A29R55 for 0V ±2 mV.

NOTE

Do not remove shield cover for the next two steps. A29R5A and A29R5B are accessible through holes in the side of the shield cover; A29R5A is near the top and A29R5B is near the bottom (connector end) of card.

d. Connect DVM to A29TP3, and adjust A29R5A for 0V ±2 mV.

e. Connect DVM to A29TP4, and adjust A29R5B for 0V ±2 mV.

f. Remove power, replace detector card A29 and re-apply power.

4.2.9 Down Converter (A28) and Scan Unit (A27)

a. Connect the display oscilloscope vertical input to SPECTRUM LIN (J2).

b. Adjust the frequency of the test oscillator at SIGNAL INPUT for maximum spectrum display.

c. Adjust the amplitude output of the test oscillator so that the INPUT OVERLOAD indicator just extinguishes. The spectrum level displayed should be 4.5V ±0.1V. If not, adjust A28R20.

d. While observing the display oscilloscope, adjust the test oscillator input level for a displayed spectrum level of 4.9V. The OUTPUT OVERLOAD indicator should just light; if it just lights, proceed to Step i. If not, perform Steps e. through i.

e. Remove power, extend the down converter circuit card (A28) in place, and re-apply power.

f. Adjust A28R35 so that the OUTPUT OVERLOAD indicator just lights when the SIGNAL INPUT is adjusted to 4.9V (as done in Step d.).

g. Remove power, remove A28 and extender card, replace A28 in its receptacle, and re-apply power.

h. Adjust (decrease) the SIGNAL INPUT for a full-scale presentation on the display oscilloscope (NORMAL indicator lighted).

i. Adjust the scan unit circuit card (A27) as follows:

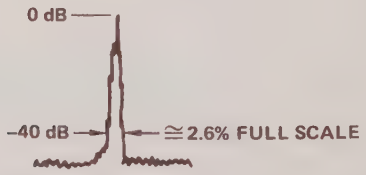
1) Connect the display oscilloscope vertical input to SPECTRUM LOG (J3).

2) See the spectrum displays illustrated below, and adjust A27R2 and A27R1 for minimum base-line flaring.

CAUTION

Do not reduce the spectrum amplitude during this adjustment. A27R2 and A27R1 interact; therefore, they must be very carefully adjusted to maintain the proper spectrum level and reduce the base-line flaring to minimum.

IMPROPERLY ADJUSTED



PROPERLY ADJUSTED

4.2.10 Final Adjustments

a. Adjust A15R44 for minimum baseline noise.

b. Adjust A29R55 clockwise for minimum low frequency baseline ripple, approximately –60 dB.

c. Set the OPER/CAL switch to SPECTRUM-CAL 0 dB; adjust A21R48 for a baseline of –55 dB.

d. Set OPER/CAL switch to –40 dB. Carefully adjust A15R4 for an accurate –40 dB level on display oscilloscope.

e. Using OPER/CAL switch and A15R4, adjust A15R4 for best accuracy at both –30 dB and –40 dB.

f. Set OPER/CAL switch to –40 dB. Using INPUT RANGE 1 dB step attenuator, adjust A15R44 so that 1 dB steps can be resolved between –40 dB and –50 dB.

This completes the calibration procedure. To check the overall operation of the unit, perform the Operational Checkout Procedure of Paragraph 2.3. If any problems still exist that may be related to calibration error, perform the comprehensive calibration procedure of Paragraph 4.3. If further information is needed, contact Spectral Dynamics Corporation, Customer Services Department.

4.3 COMPREHENSIVE CALIBRATION

This procedure is an extension of the normal calibration procedure of Paragraph 4.2. It should not be performed unless a problem directly related to a calibration error still exists after performing the procedure of Paragraph 4.2.

This procedure provides additional instructions for checking and adjusting the marker generator (A18), the high-speed D/A ladder (A1), the down converter (A28), and the scan unit (A27).

CAUTION

The adjustments described in the following procedures are very critical to the overall proper operation of the SD301C, and should only be performed by a person whose knowledge and experience level is at least that of a senior electronic technician.

4.3.1 Marker Generator (A18)

The spectrum calibrate signal is generated on the marker generator card (A18). This calibration signal is always 3/10 of full scale frequency output regardless of the selected setting of the ANALYSIS RANGE switch. A square wave is used for the calibrate signal; therefore, the third harmonic is present in the spectrum output.

a. Connect test oscillator to the SIGNAL INPUT (J24). Adjust test oscillator frequency for approximately 600 Hz at 1 Vrms ±5 mV rms.

b. On SD301C, set coarse INPUT RANGE switch to 1, ANALYSIS RANGE switch to 2K, MODE to SCOPE SLOW.

c. Set OPER/CAL switch to SPECTRUM CAL 0 dB. Adjust the frequency offset control, if necessary, to maximize the spectrum amplitude. The amplitude of the spectrum line should be equal to ±5 mV of that of Step b. If not, select a new value for A18R35 to obtain proper signal amplitude.

4.3.2 High Speed D/A Ladder (A1)

a. Set the FREQUENCY MARKERS switch to OFF, the ANALYSIS RANGE switch to 10K, and press the MEMORY UPDATE push button.

b. Place the instrument on its right side (as viewed from the front), and remove the bottom cover.

c. Apply a 50-Hz triangular wave signal to the SIGNAL INPUT. Adjust the test oscillator output control so that the OVERLOAD indicator just lights.

d. The memory is now filled, so press the MEMORY HOLD push button.

e. Connect a high frequency oscilloscope (Tektronix Model 454 or equivalent) to card connector XA1-3. (Do not extend card A1.) Trigger the oscilloscope from J21, MEMORY SYNC connector on the rear chassis. Use a probe with tip shield grounding provisions and ground directly to card connector XA1-4. The waveform should be an approximate 25-kHz triangular waveform with a discontinuity appearing at a 10-kHz rate. The waveform will be made up of steps, each about 67 ns wide and 2 mV high. The voltage steps were adjusted with the Model SD35-1 Ladder Test Fixture. If large transients are present, they can be reduced as prescribed in the following Steps f. through j.

f. When the level makes a transition from one step to the next, transients may occur. They are caused by variance in propagation times for different signals in the ladder. Before making any adjustments to lessen them, ensure that the transients are not stray pickup. The bandwidth of this circuit is above 100 MHz; high frequency pulses are normally present and can cause confusion in nulling out the propagation transients. Proceed as follows:

g. Adjust A1R1, -R3, -R5, -R7, -R9 and -R11 to their extreme counter-clockwise position. (Their nominal position is near the counter-clockwise end of their rotational range.)

h. Adjust A1R2, -R4, -R6, -R8, -R10 and -R12 to their extreme clockwise position. (Their nominal position is near the clockwise end of their rotational range.)

i. Adjust clockwise in sequence, A1R1, -R3, -R5, -R7, -R9 and -R11 for minimum transients. These adjustments interact, so several trials may be required.

j. Adjust counter-clockwise in sequence, A1R2, -R4, -R6, -R8, -R10 and -R12 until the transients are reduced to a minimum. (Several trials may be necessary.) If no improvement is noticed, leave controls in their extreme clockwise position.

4.3.3 Scan Unit (A27)

a. Remove power, extend the scan unit card (A27) in its receptacle, and re-apply power. With the scan circuit card extended, the coaxial lead from the down converter (A28) must be extended using an 8-inch (maximum) coaxial jumper with proper fittings.

b. Ensure that the SD301C front-panel controls are set as follows:

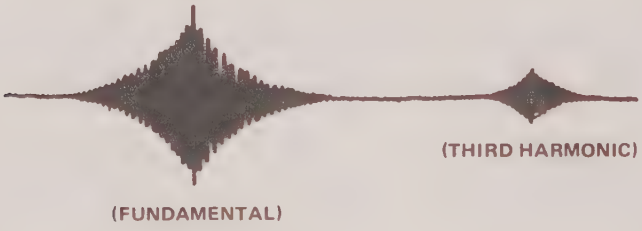
INPUT RANGE	1(Vrms)
FREQUENCY MARKERS	OFF
ANALYSIS RANGE	10K
OUTPUT GAIN	X1
OPER/CAL	SPECTRUM-CAL 0 (dB)
MODE	SCOPE FAST
Sweep Initiation Switch	AUTO

c. Observe the signals on A27 Pin 13 and A27TP2, trigger on Pin 13.

d. Adjust L2 for a 90° relationship between the square wave on Pin 13 and the filtered signal on A27TP2.

e. Connect test oscilloscope vertical input to A27E1 (at top of A27); connect horizontal input to FREQUENCY LIN.

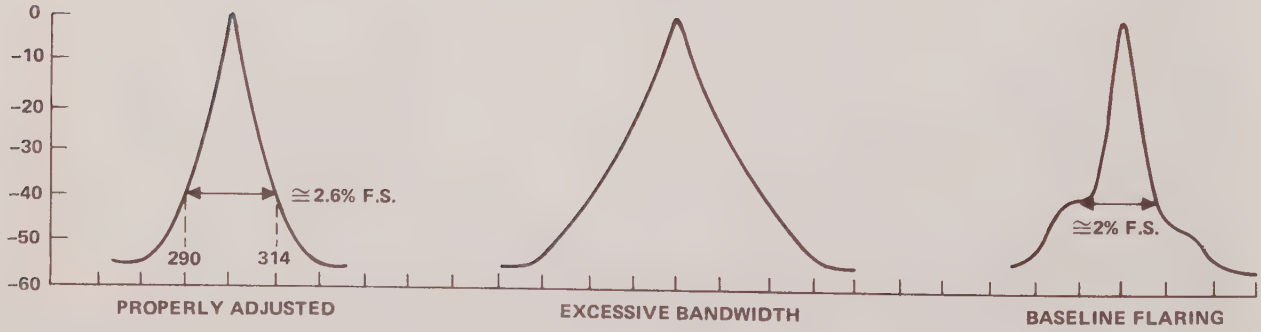
f. Adjust A24L9, then A24L1 for maximum amplitude on test oscilloscope. (See signal illustration below.)



g. On S.A.M. subassembly 11650-1, adjust L3 for peak signal at A27E1.

h. Remove power, and re-install scan unit circuit card (A27) into its receptacle. Re-apply power and allow 5-minute warmup.

i. Using the display oscilloscope X-axis gain control and X10 magnifier, adjust for maximum signal display width. The criterion for adjusting the scan circuit card is to adjust A27R1 (weighting amplitude) and A27R2 (bias) for minimum baseline flaring of the SPECTRUM LOG output. See the following illustration:



j. Connect the test oscilloscope to A27E2. (Be sure oscilloscope probe is compensated using square wave calibration.)

k. Adjust A27R2 for 1.5V p-p at A27E2.

l. Adjust A27R1 until flaring is observed. Now adjust A27R1 in opposite direction to minimize the baseline flare and stop adjustment when the baseline flare does not reduce further. Continued adjustment only reduces amplitude without improvement in total baseline flare.

m. Repeat Steps k. and l. for minimum baseline flaring and 1.5V p-p at A27E2.

4.3.4 Down Converter (A28)

a. Remove power and pull out down converter circuit card (A28). Remove the cover that shields the 17.8-MHz oscillator and 18-MHz I.F. subassembly on the down converter circuit card (A28) and extend the card in its proper location. Use a short coaxial jumper (8 inches maximum) with proper fittings to extend existing coaxial cable.

b. Apply power and allow at least a 5-minute warmup. Ensure that OUTPUT GAIN switch is set to X1 position.

c. Connect frequency counter to A28TP2. Adjust A28C13 (next to Y1 at bottom on 17.8-MHz Oscillator subassembly) for counter reading of 17.8 MHz ·500 Hz.

d. Remove power, re-install metal cover over oscillator and I.F. subassemblies on circuit card A28, and re-apply power.

e. Disconnect the counter, and connect test oscilloscope to A28TP2. Using access holes in the side of the shielded compartment, tune L2 and L3 for maximum amplitude on oscilloscope. Now adjust R13 (access hole just below L2) for 1.4V p-p. (Be sure oscilloscope probe is properly compensated using square wave calibration.)

f. Connect test oscilloscope to A28TP1; connect horizontal input to FREQUENCY LIN.

g. Tune L1 on the 18-MHz I.F. subassembly for maximum amplitude on the oscilloscope at A28TP1.

h. Adjust R12 on the 18-MHz I.F. subassembly for a fundamental of 330 mV p-p. (Refer to waveform drawing below Step f. of Paragraph 4.3.3.)

i. Adjust A28R20 for 7V p-p at A28TP5.

j. Remove power and then connect a 1k, 5% resistor in series with short jumper wires between pins 12 and 21 (+4.9V supply) of the down converter circuit card A28. Re-apply power.

k. First adjust A28R35 so output OVERLOAD indicator is lighted; then re-adjust A28R35 until output OVERLOAD indicator is just extinguished.

l. Remove power and then remove 1k resistor and jumper connections between Pins 12 and 21 of circuit card A28.

m. Re-install down converter (A28) into its proper receptacle, and re-apply power.

4.3.5 Final Adjustments

a. On SD301C, set the front-panel controls as follows:

OPER/CAL	SPECTRUM-CAL, 0 dB
FREQUENCY MARKERS	OFF
MODE Switch	PLOTTER

b. Connect a DVM to SPECTRUM LIN STEP (J1 on rear chassis), and adjust Frequency Offset control for maximum DVM reading.

c. Finely adjust A28R20 for 4.9V (4.85 to 4.95V) at J1.

d. Set OPER/CAL switch to SPECTRUM-CAL LIN ZERO, and connect DVM to SPECTRUM LIN (J2). Adjust A29R55 on detector circuit card (A29) for 0V ±2 mV at J2.

e. Set OPER/CAL switch to 0 (dB), and MODE switch to SCOPE FAST.

f. Adjust A21R48 on output amplifier circuit card (A21) for a display lower limit of the SPECTRUM LOG OUTPUT at approximately –55 dB. This limit may be adjusted for any level depending upon the particular application.

g. Connect oscilloscope probe (less than 50 pF capacity) to A15TP3 on comparator circuit card. Adjust A15R44 for a dither signal level of approximately 25 mV p-p at A15TP3.

h. Remove power and test equipment, replace top and bottom covers, and place instrument in service.

4.4 PARTS REPLACEMENT

Except for some special SDC specification-controlled parts listed in Table 4-2, which must be ordered from Spectral Dynamics Corporation, standard electronic parts have been used throughout the instrument. Although standard, the pilot lamp bulbs, switches, fuses and power cord have been included to aid in their replacement. Spectral Dynamics Corporation maintains a complete stock of all parts and complete printed circuit card assemblies used in this instrument.

When ordering a replacement part or assembly, be sure to include the reference designation, the part number or manufacturer's designation, and a complete description; include also the instrument name, model number, and serial number.

Table 4-2. Special Replaceable Parts List

Reference Designator	Description	Part Number/ Mfr. Designation
A1	Circuit Card, High-Speed D-A	12552-1
A2	Circuit Card, Clock	14162-1
A3–11	Circuit Card, Memory	14996-1
A12	Circuit Card, Digital Indicator	11380-1
A13	Circuit Card, Number Generator	13942-3
A14	Circuit Card, Ladder	12750-101
A15	Circuit Card, Comparator	14860-3
A16	Circuit Card, Display Control	12514-1
A17	Circuit Card, Counter Control	10080100
A18	Circuit Card, Marker Generator	12520-1
A19	Circuit Card, Counter	12518-1
A20	Circuit Card, BCD Ladder	01580200

Table 4-2. Special Replaceable Parts List (Continued)

Reference Designator	Description	Part Number/ Mfr. Designation
A21	Circuit Card, Output Amplifier	11430-1
A25	Circuit Card, 12—23 MHz VCO	15444-1
A26	Circuit Card, Mixer & RTA Output Amplifier	15312-1
A27	Circuit Card, Scan Unit	15586-1
A28	Circuit Card, Down Converter	11440-3
A29	Circuit Card, Detector	14992-1
A30	Circuit Card, Extender	11546-1
A32	Circuit Card, Input	15048-1
A33	Circuit Card, Power Supply	11504-3
TB1	Terminal Board Assembly	11548-3
A21Q2,Q3 A21Q5,Q6 A26Q8A,B	Transistors, 2N3391A's, matched pair	20014-044
A27FL1	Filter, Bandpass, 18 MHz	20013-271
A27FL2	Filter, Bandpass, 6 MHz	20013-215
A32S1	Switch Index Assy., ANALYSIS RANGE	20013-401-5
A32S1A-K	Switch Wafer, ANALYSIS RANGE	20013-400-1
DS3—DS12	Lamp Bulb, OUTPUT OVERLOAD, LOW, 1/2, 3/4, NORMAL, INPUT OVERLOAD, TRANSIENT CAPTURE, UPDATE, HOLD, SINGLE/RESET	345 (Chicago Miniature of G.E.)

Table 4-2. Special Replaceable Parts List (Continued)

Reference Designator	Description	Part Number/ Mfr. Designation
DS13	Lamp Bulb, POWER	A1H (Chi. Min. or G.E.)
F1	Fuse, POWER, 2-1/2A SLO, 3AG	Buss Littlefuse
F2	Fuse, +5V Supply, 10A SLO, 3AG	Buss Littlefuse
F3,F4	Fuse, +12, –12 SUPPLIES, 3A SLO 3AG	Buss Littlefuse
S2,S4	Switch INPUT RANGE (Vrms) coarse, MODE	20013-322
S3	Switch, OPER/CAL	20013-236
S5,S7	Switch, Sweep Initiation, FREQUENCY MARKERS	7203(C&K)
S9–S12	Switch, Push Button; TRANSIENT CAPTURE, UPDATE, HOLD, SINGLE/RESET	54-61881-25 (MARCO OAK)
S13	Switch, Push Button, POWER	54-61681-26 (MARCO OAK)
S14	Switch, INPUT RANGE fine–0/CAL	20013-324
S15,S16	Switch, OUTPUT GAIN, DIGITAL LOCATER	20013-352
T1	Transformer, Power	20013-227
	Knob (double index), OUTPUT GAIN	20013-174
	Knob (single index), INPUT RANGE (Vrms), coarse and fine, ANALYSIS RANGE, MODE, OPER/CAL, DIGITAL LOCATER	20013-175
	Power Cord	17258-S (Belden)

4.5 TROUBLESHOOTING

One need not become an expert on the SD301C to perform simple troubleshooting procedures that will in most cases isolate the problem. Pull out the foldout Figure 4-2 and see how simple the basic concept of operation really is. Here, we took the liberty of dispensing with an age-old problem, and put the "egg" first; then after some manipulation, ended up with the "chicken"!

Of course, knowing the overall theory of operation as described in Section III – at least to the functional block diagram level – is definitely an attribute. With that tucked away, the Troubleshooter's Functional Block Diagram, Figure 4-3, becomes a reality. So as not to clutter the drawing with every conceivable waveform, only the most pertinent have been drawn in; the rest are illustrated in Table 4-4 at the end of this section.

After meditating on the functional block diagram for awhile, proceed to the "RTA Troubleshooting Guide," Table 4-3. The statement usually inserted at this point reads something like this: "The Troubleshooting Guide does not attempt to list all the possible troubles that may occur in the instrument. However, it has been compiled from those troubles most frequently experienced by us and by our customers in the field." Unfortunately, the preceding statement is true, but we're including the table anyway, based on the following premise: If the instrument has been used in the approved configurations described in Section II, Operation, with some luck your SD301C might experience only the same problems that we know about. If your particular problem is listed in the table, refer also to Figure 4-4, the Troubleshooting Tree; it should lead you out on the right limb.

Now if a problem does occur that cannot be cured after using all of the troubleshooting aids, please contact the Customer Services Department of Spectral Dynamics Corporation. They will work with you, using all of their experience and that of the Engineering Department, if necessary, to solve your problem. We haven't lost a "patient" yet!

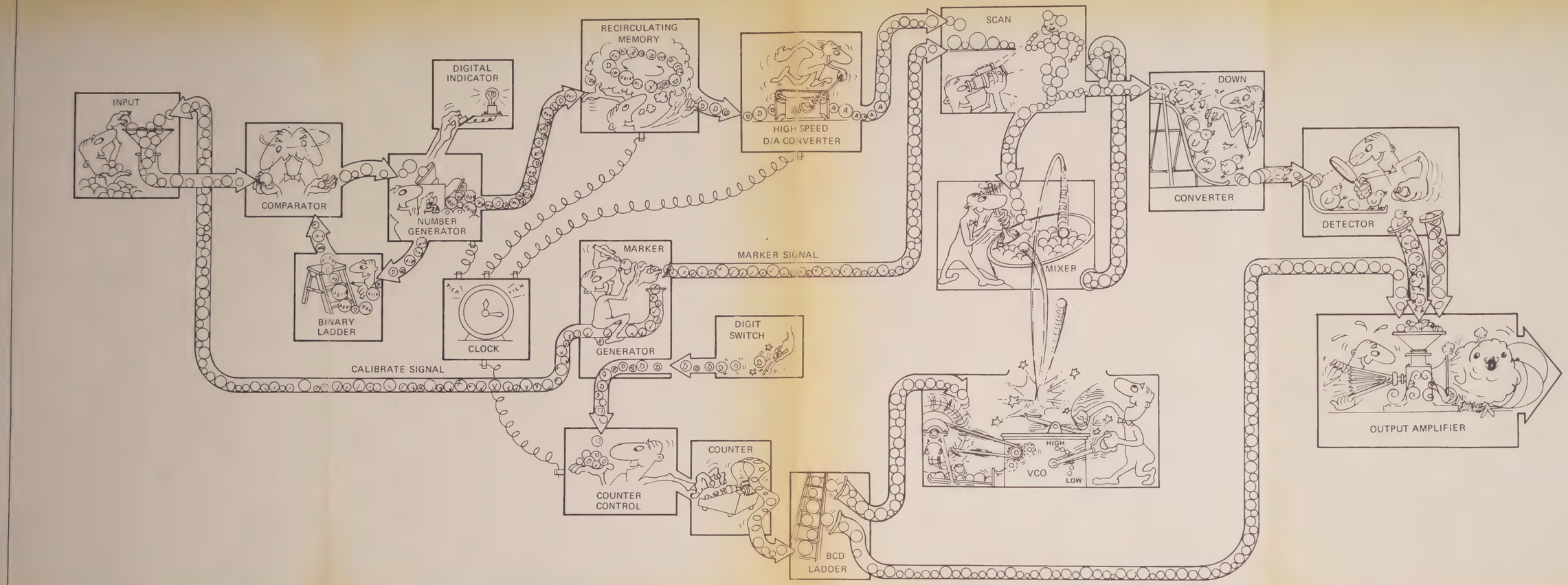
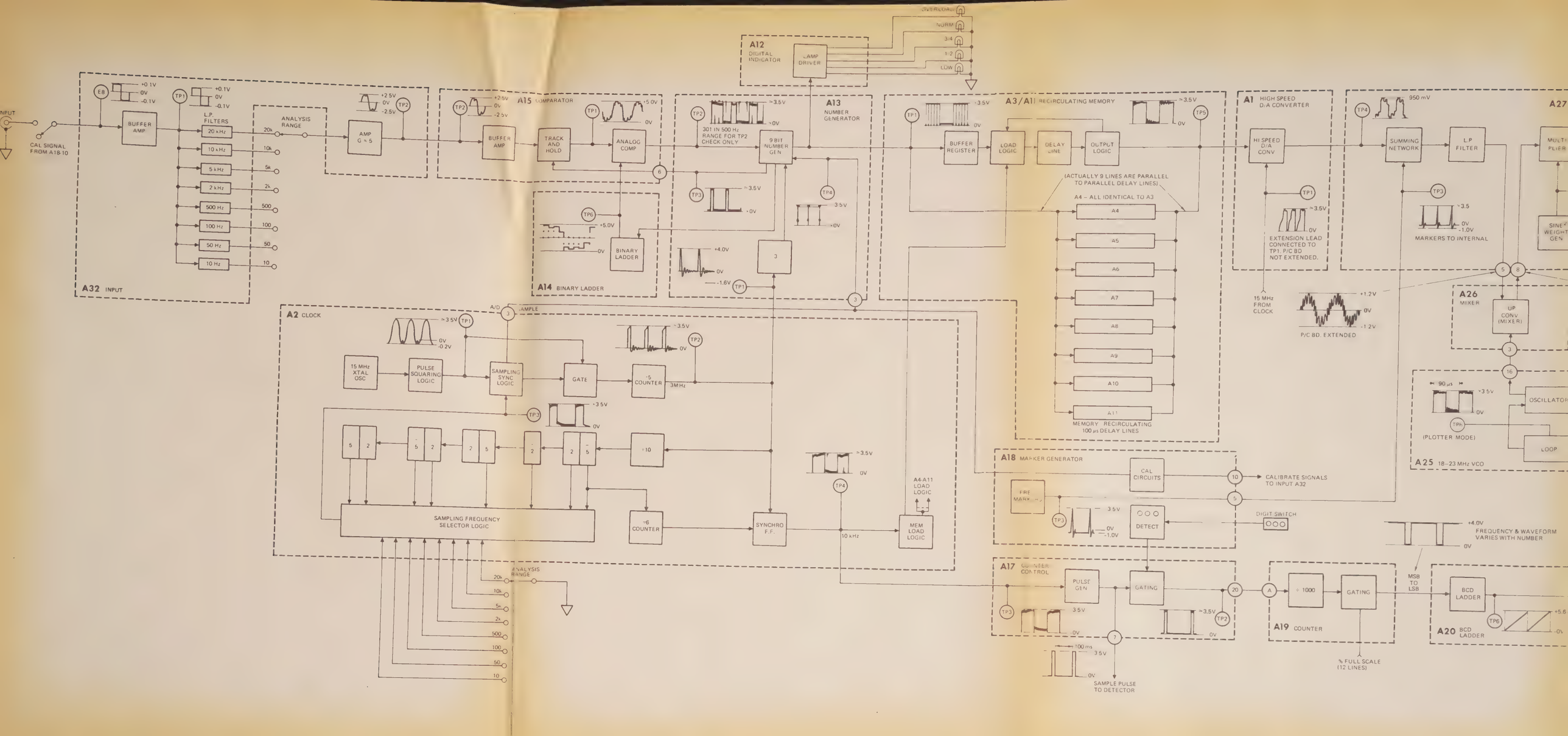


Figure 4-2. Super Simplified Block D


A12 DIGITAL INDICATOR
LAMP DRIVER
OVERLOAD
NORM
3/4
1/2
LOW
A32 INPUT
INPUT
CAL SIGNAL FROM A18-10
E8
BUFFER AMP
TP1
L.P. FILTERS
20 kHz
10 kHz
5 kHz
2 kHz
500 Hz
100 Hz
50 Hz
10 Hz
ANALYSIS RANGE
AMP G = 5
A15 COMPARATOR
TP2
BUFFER AMP
TRACK AND HOLD
ANALOG COMP
A14 BINARY LADDER
TP6
BINARY LADDER
A13 NUMBER GENERATOR
301 IN 500 Hz RANGE FOR TP2 CHECK ONLY
9 BIT NUMBER GEN
A3/A11 RECIRCULATING MEMORY
BUFFER REGISTER
LOAD LOGIC
DELAY LINE
OUTPUT LOGIC
(ACTUALLY 9 LINES ARE PARALLEL TO PARALLEL DELAY LINES)
A4 – ALL IDENTICAL TO A3
A4
A5
A6
A7
A8
A9
A10
A11
MEMORY RECIRCULATING 100 µs DELAY LINES
A1 HIGH SPEED D/A CONVERTER
HI SPEED D/A CONV
EXTENSION LEAD CONNECTED TO TP1, P/C BD NOT EXTENDED.
15 MHz FROM CLOCK
P/C BD. EXTENDED
A27
SUMMING NETWORK
L.P. FILTER
MULTIPLIER
SINE WEIGHTING GEN
MARKERS TO INTERNAL
A26 MIXER
UP CONV (MIXER)
A25 18–23 MHz VCO
OSCILLATOR
LOOP
(PLOTTER MODE)
A2 CLOCK
A/D SAMPLE
15 MHz XTAL OSC
PULSE SQUARING LOGIC
SAMPLING SYNC LOGIC
GATE
÷5 COUNTER
3MHz
÷10
SAMPLING FREQUENCY SELECTOR LOGIC
÷6 COUNTER
SYNCHRO F.F.
10 kHz
MEM LOAD LOGIC
A4-A11 LOAD LOGIC
ANALYSIS RANGE
A18 MARKER GENERATOR
CAL CIRCUITS
CALIBRATE SIGNALS TO INPUT A32
DETECT
DIGIT SWITCH
A17 COUNTER CONTROL
PULSE GEN
GATING
÷1000
A19 COUNTER
% FULL SCALE (12 LINES)
MSB TO LSB
BCD LADDER
A20 BCD LADDER
FREQUENCY & WAVEFORM VARIES WITH NUMBER
SAMPLE PULSE TO DETECTOR

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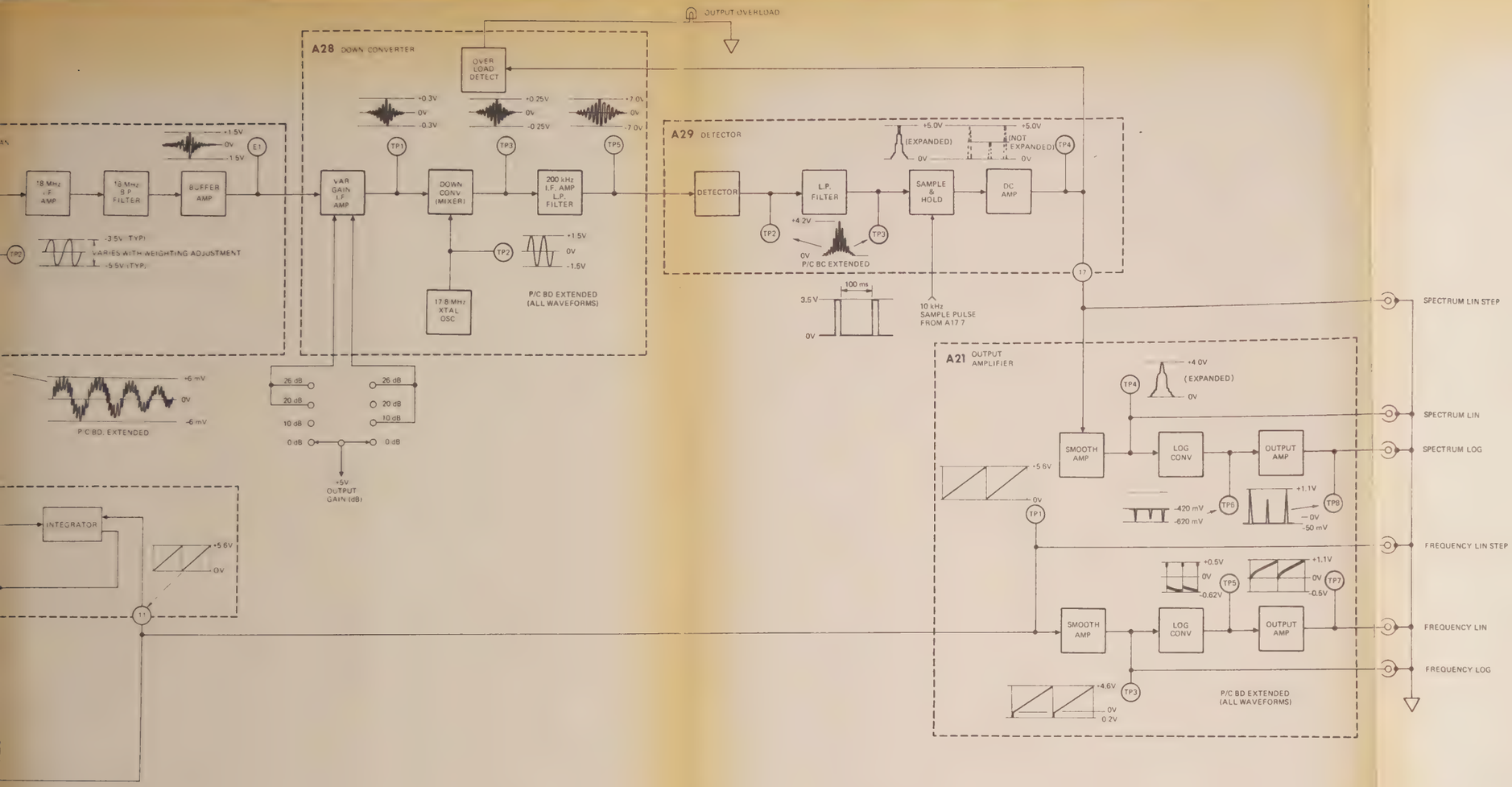


NOTE: ALL VOLTAGES ARE APPROXIMATE

Figure 4-3. Troubleshooter's Functional Block Diagram
Model SD301C Real Time Analyzer

Table 4-3. RTA Troubleshooting Guide

Problem	Possible Solution
Spectrum line:	1) Adjust R1 and R2 on SCAN for proper weighting. 2) Weighting signal missing if this problem occurs at one group of frequencies.
Spectrum line dropout at one frequency	Ladder, High Speed Calibration or bad current generator on either of these boards.
Data Burst on display scope at particular amplitude or frequency	Bad memory, bad clock (the clock signal breaking up)
Base line growing weeds:	Bad memory, bad clock (the clock signal breaking up)
Noise floor limiting (flat) i.e., dynamic range <54 dB	Adjust detector per cal procedure
Lin Step Magnitude error	Adjust R5, R1, R2 on SCAN for magnitude and weighting, respectively
Panic show!! Display (Spectrum Cal Signal)	Adjust R5, R1, R2 on SCAN for magnitude and weighting, respectively

Table 4-3. RTA Troubleshooting Guide (Continued)

Problem	Possible Solution
Lin Step Output (freq.) missing – should be: (ramp) but is:	Bad Counter which pulses the ladder and in turn the VCO
Lin Output (Spectrum or Freq) but no log output	Check Log Converter on X-Y Output Card
Spectrum Linearity error at 30–40 dB (≅1–2 dB error only)	Slightly adjust comparator pot close to top of board
Excessive Spectrum Linearity error	1) Re-cal Comparator 2) Defect Comparator or S/H circuit 3) Defective Memory – check for pulses at TP5
Display missing on one frequency range	Bad input filter (A27) or bad (open) Normalize Pot
No Level Lamp indication – other lamps on	Look for Display control output to lamp drivers
All Lamps OFF – front panel dead	+5V Fuse located on top of power supply

Table 4-3. RTA Troubleshooting Guide (Continued)

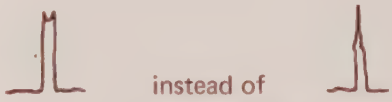
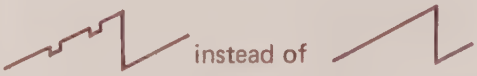
Problem	Possible Solution
Excessive local oscillator spur, i.e., zero freq. 	1) Adjust VCO scope Zero – such that L.O. is in view 2) Carefully adjust two trimmers and variable resistor for min. 3) Re-cal VCO per procedure
Signal on Comparator S/H circuit but missing from MEM CONTENTS output	1) High Speed D/A Calibration 2) Defective control F.F.'s on Number Generator
 instead of i.e., double peak	Ladder calibration – Check with SD35-1 Ladder Test Fixture
Ladder will not cal in one position	1) Defective input switching transistor (Q1–Q9) 2) Defective current generator (Q10–Q18)
Data dropout along X-axis – ladder ramp looks like:  instead of	1) Defective input switching transistor (Q1–Q9) 2) Defective current generator (Q10–Q18)
Spectrum display noisy	Memory driving F.F. on Number Generator, i.e., improper memory input

Table 4-3. RTA Troubleshooting Guide (Continued)

Problem	Possible Solution
Post Filter Gain inoperative	Relay K1 or K2 on Down Converter Board sticking
Spectrum Linearity defective when using Range switch Vernier Control or step attenuator	Input offsets within Input Amplifier – perform calibration
Spectrum Bandwidth too wide – weighting adjustment will not fix problem	Replace 18 MHz Filter
Spectrum distortion in region of –2 dec below full frequency scale	L.O. spur – Calibrate VCO
Transient Input defective	Display Control Board defective
Pen Lift inoperative	Replace K1 on Display Control Board
Small group of spurs at upper end of frequency range	Readjust R1–R8, R68, R69 on High Speed D/A
No spectrum data out – markers, however, OK	Trouble in TCU section – 1) Q28 on High Speed D/A 2) Exchange Ladders 3) Check Counter output

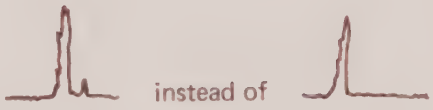
Table 4-3. RTA Troubleshooting Guide (Continued)

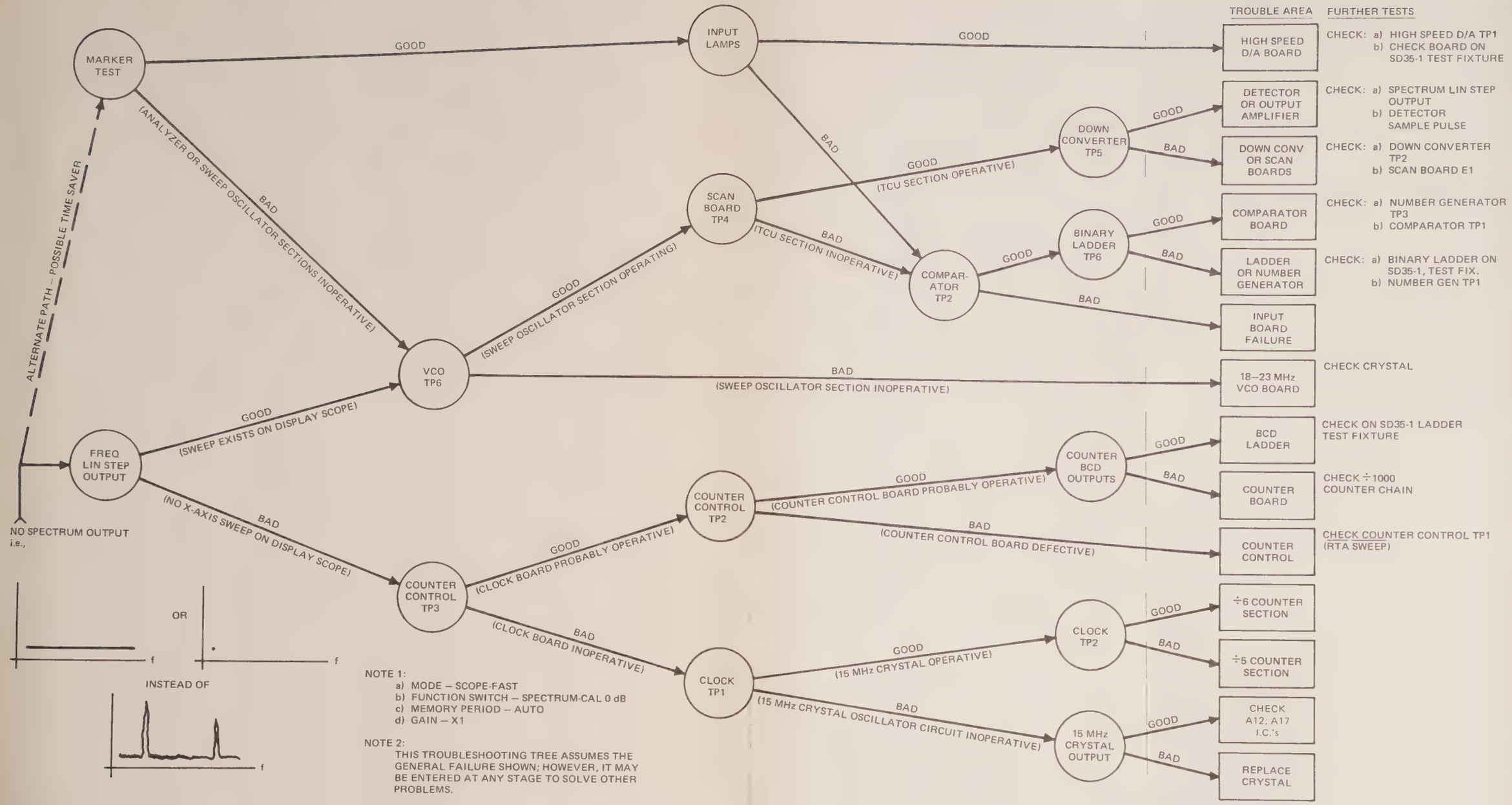
Problem	Possible Solution
Large offset between EXT AVG and SCOPE modes	Defective I.C. on Output Amplifier
SCOPE mode display remains after switching to EXT AVG mode	Replace K1 on the Output Amplifier
Frequency axis unstable, i.e., spectrum line jitters slightly along x-axis	1) Check power supply for stability and ripple 2) Check -8.5V and 17V reference supplies on A22
High frequency noise and simulated markers with markers switched off	1) Check Clock Board frequency for 14.980 MHz 2) Remove one Memory Board at a time and check operation
Frequency axis very non-linear as seen by using the frequency markers	BCD ladder defective or misadjusted. Use SD35-1 Ladder Test Fixture
Double peaked spectrum display after warmup	BCD ladder defective or misadjusted. Use SD35-1 Ladder Test Fixture
Spectrum linearity very poor. Lin Spectrum output 2—3 volts instead of 5 volts	Check signal amplitude on SCAN and Down Converter Boards
Nine markers instead of ten after warmup	Check operation of the Current Generator Board

Table 4-3. RTA Troubleshooting Guide (Continued)

Problem	Possible Solution
Four markers for first 15–30 minutes of operation	Check Marker Generator Crystal circuit. Check that crystal case is grounded
Spectrum linearity defective. Also, the Y-axis base line drifts up and down	Check output amplifier I.C.'s for drift, particularly the base line clamp circuit
Output goes dead after 30–60 minutes of operation	Check Detector Board operation
Input lamps on without Signal Input. No SPECTRUM-CAL output	Check operation of Input Board (behind front panel)
Excessive spikes along base line when signal applied	Check operation of High Speed D/A and Clock Board
Y-axis base line 10–20 dB above normal	Check calibration of Detector for offset voltages
Lower Frequency ranges noisy	Check Clock sampling frequency outputs
Spectrum noise and intermittent base line flutter	Check the Clock Board operation, particularly the clock and $\overline{\text{clock}}$ outputs
Reduced Marker amplitude after warmup	Check Marker Generator Board, particularly the marker output I.C.

Table 4-3. RTA Troubleshooting Guide (Continued)

Problem	Possible Solution
10 dB spur at 0.75 full scale in all ranges	Comparator not adjusted properly Check for 2.410V at A15TP1
RTA output display noisy when connected to SD307 or SD305	Normal operation if the SD305 or SD307 are off. Unit must be on.
 instead of	Defective 18 MHz crystal filter on SCAN BOARD



NOTE 1:
a) MODE – SCOPE-FAST
b) FUNCTION SWITCH – SPECTRUM-CAL 0 dB
c) MEMORY PERIOD – AUTO
d) GAIN – X1

NOTE 2:
THIS TROUBLESHOOTING TREE ASSUMES THE GENERAL FAILURE SHOWN; HOWEVER, IT MAY BE ENTERED AT ANY STAGE TO SOLVE OTHER PROBLEMS.

Figure 4-4. Troubleshooting Tree

Table 4-4. Testpoint Waveforms

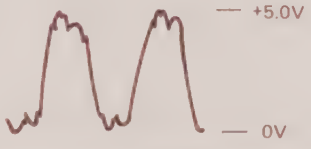
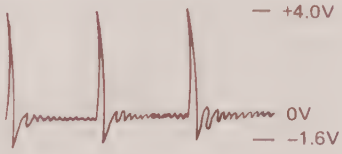
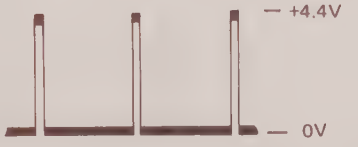
ASSEMBLY	TEST POINT	WAVEFORM
A32	E8	
	TP1	
	TP2	
A15	TP2	SAME AS A32, TP2
	TP1	
A14	TP6	
A13	TP1	
	TP2	SD301 IN 500 Hz RANGE FOR TP2 CHECK ONLY
	TP3	

Table 4-4. Testpoint Waveforms (Continued)

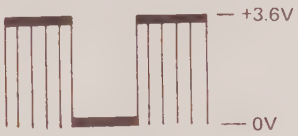
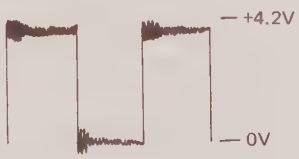
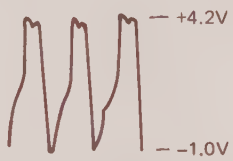
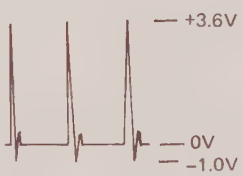
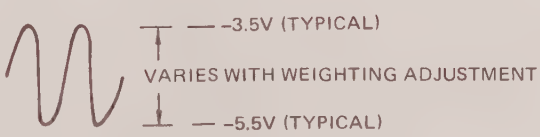
ASSEMBLY	TEST POINT	WAVEFORM
A13	TP4	
A3-A11	TP1	
	TP5	
A1	TP1	 EXTENSION LEAD CONNECTED TO TP1. P.C. BOARD NOT EXTENDED
A27	TP4	
	TP3	 MARKERS TO INTERNAL
	TP2	
	E-1	

Table 4-4. Testpoint Waveforms (Continued)

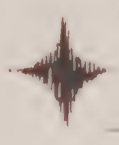
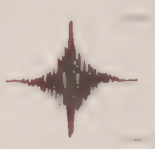
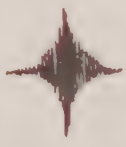
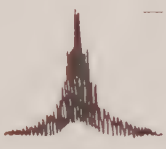
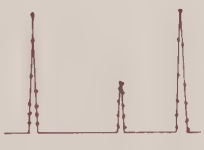
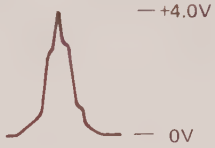
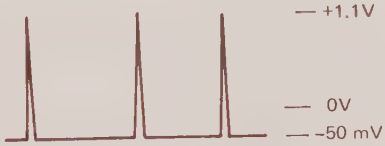
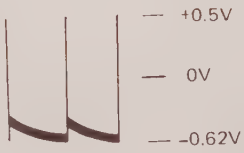
ASSEMBLY	TEST POINT	WAVEFORM	
A28	TP1		P.C. BOARD EXTENDED
	TP2		" "
	TP3		" "
	TP5		" "
A29	TP1		P.C. BOARD EXTENDED
	TP2	SAME AS TP1	" "
	TP3		" "
	TP4		

Table 4-4. Testpoint Waveforms (Continued)

ASSEMBLY	TEST POINT	WAVEFORM
A21	TP9	SAME AS A29-TP4
	TP4	
	TP6	
	TP8	
	TP2	SAME AS A29-TP4 & A21-TP9
	TP1	
	TP3	
	TP5	
	TP7	

P.C. BOARD EXTENDED FOR ALL WAVEFORMS

Table 4-4. Testpoint Waveforms (Continued)

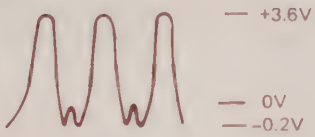
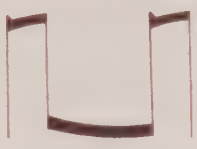
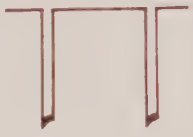
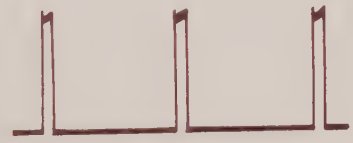
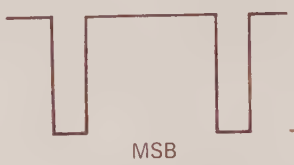
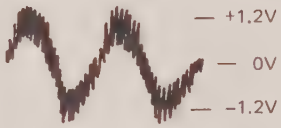
ASSEMBLY	TEST POINT	WAVEFORM
A2	TP1	 P.C. BOARD EXTENDED FOR ALL TEST POINTS
	TP2	
	TP3	
	TP4	
A18	TP1	
	TP2	
	TP3	MARKERS TO INTERNAL
A17	TP3	SAME AS A2-TP4
	TP2	

Table 4-4. Testpoint Waveforms (Continued)

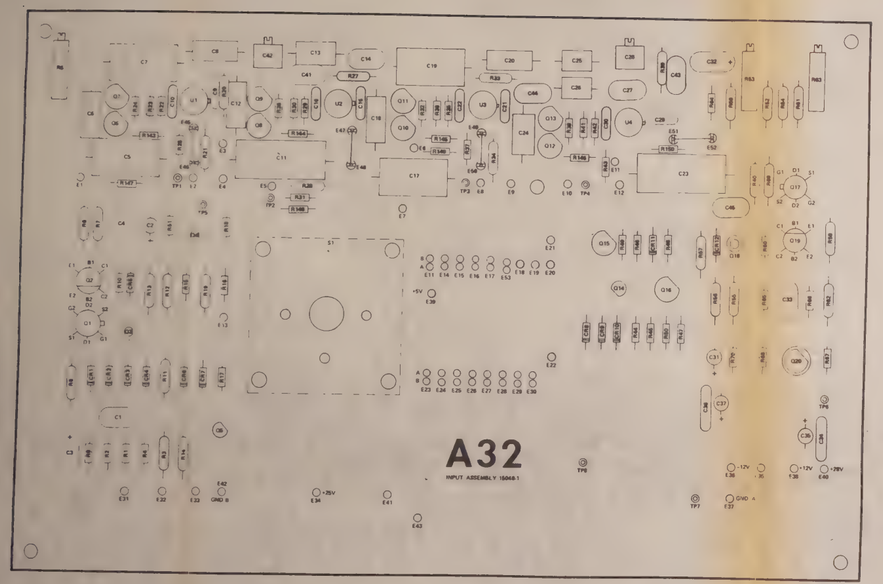
ASSEMBLY	TEST POINT	WAVEFORM
A19	DIGITAL TUNING CONTROL NUMBER	 FREQUENCY AND WAVEFORM VARIES WITH BIT NUMBER
A20	TP6	
A26	PIN 5	 P.C. BOARD EXTENDED
	PIN 8	P.C. BOARD EXTENDED

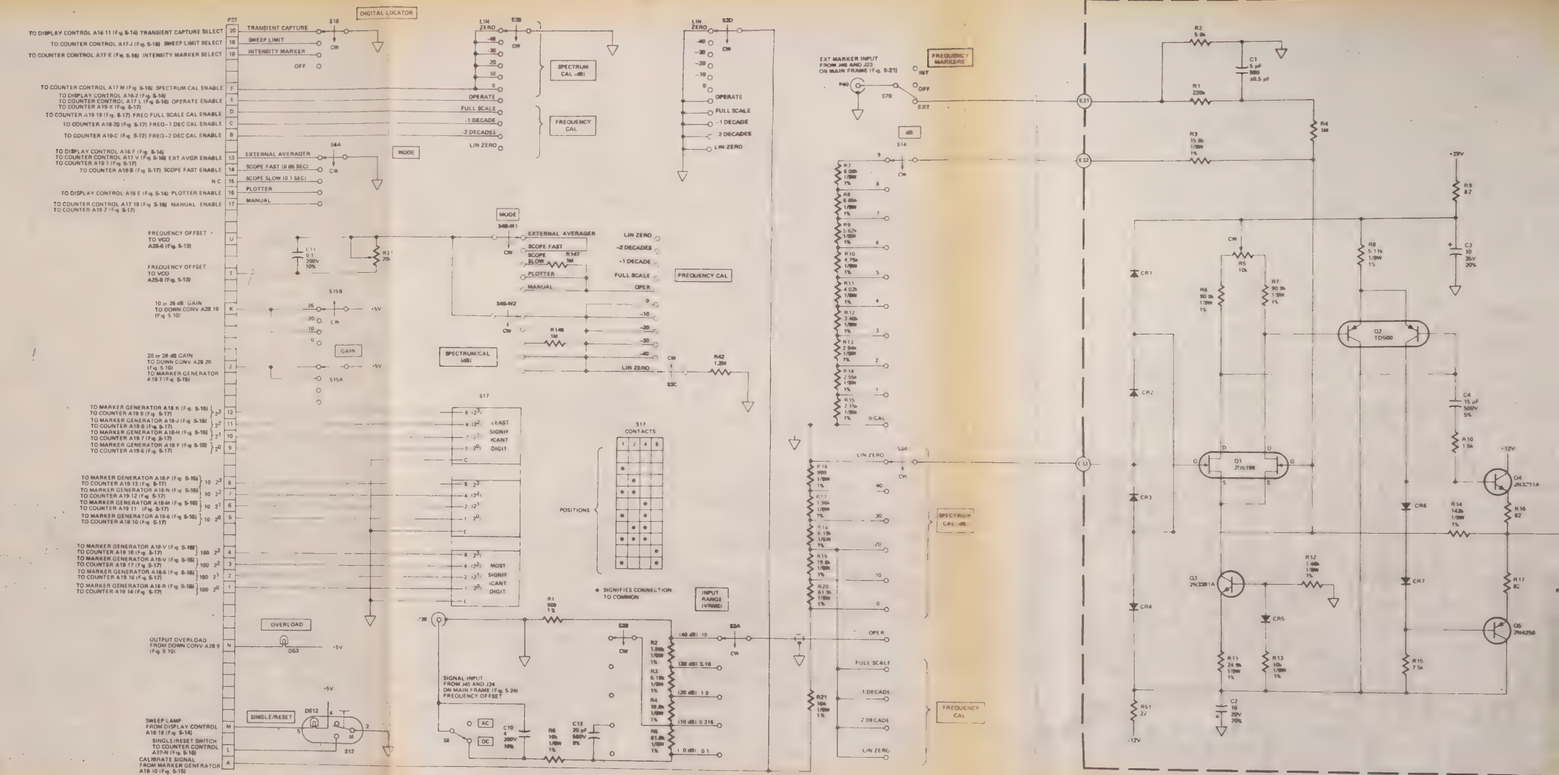
SECTION V

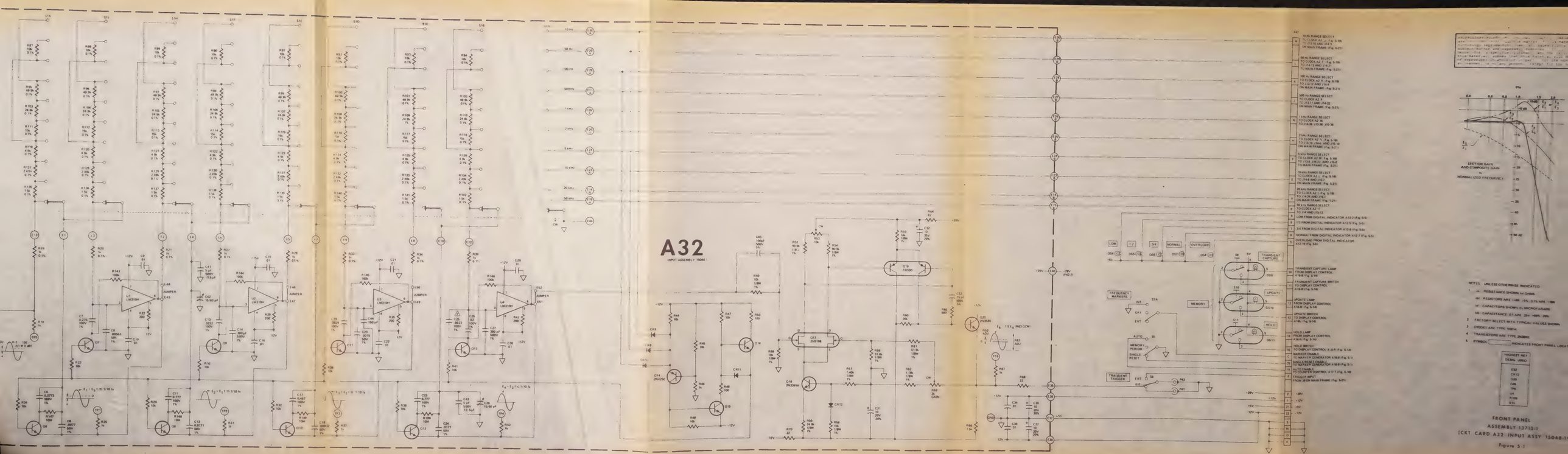
CIRCUIT DIAGRAMS AND COMPONENT IDENTIFICATION

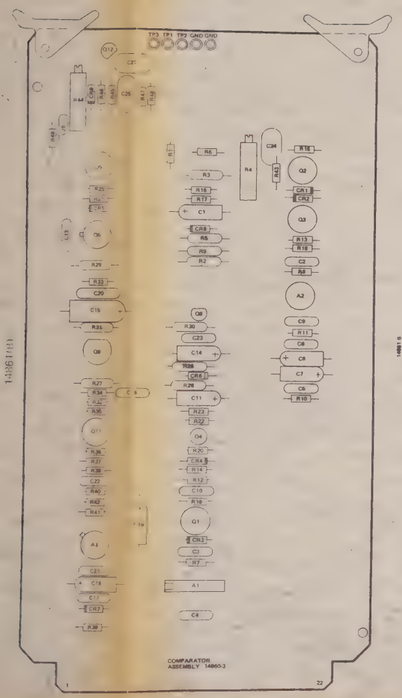
5.1 INTRODUCTION

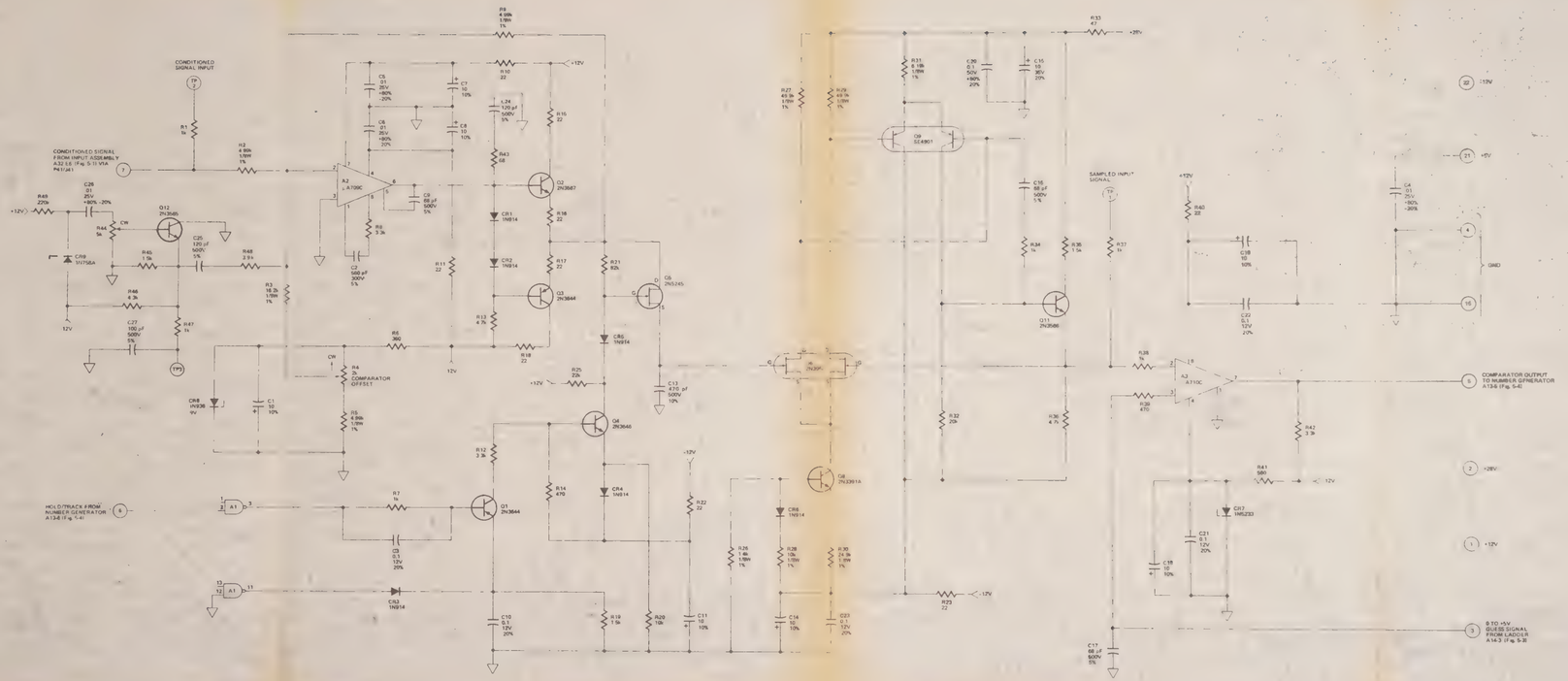
This section containing Figures 5-1 through 5-21 in numerical sequence, provides complete schematic coverage and individual circuit card component identification of the Model SD301C Real Time Analyzer. Generally, each printed circuit card type is presented as a separate drawing, with information relative to its interconnection in the instrument. However, for overall interconnecting information reference should be made to Figure 5-1, Input Assembly; Figure 5-20, Power Supply Assembly; and Figure 5-21, Main Frame Assembly.


A32
INPUT ASSEMBLY 150661


DIGITAL LOCATOR
TRANSIENT CAPTURE
SWEEP LIMIT
INTENSITY MARKER
OFF
SPECTRUM CAL (dB)
FREQUENCY CAL
OPERATE
FULL SCALE
1 DECADE
2 DECADES
LIN ZERO
MODE
EXTERNAL AVERAGER
SCOPE FAST (0.05 SEC)
SCOPE SLOW (0.1 SEC)
PLOTTER
MANUAL
FREQUENCY OFFSET TO VCO
GAIN
OVERLOAD
SINGLE/RESET
SIGNAL INPUT FROM J46 AND J24 ON MAIN FRAME (Fig. 5-24) FREQUENCY OFFSET
INPUT RANGE (VRMS)
EXT MARKER INPUT FROM J46 AND J23 ON MAIN FRAME (Fig. 5-21)
FREQUENCY MARKERS
SIGNIFIES CONNECTION TO COMMON


A32
INPUT ASSEMBLY 15048-1
10 Hz
50 Hz
100 Hz
500 Hz
1 kHz
2 kHz
5 kHz
10 kHz
20 kHz
50 kHz
100 kHz
CW
10 Hz RANGE SELECT
TO CLOCK A2 1 (Fig. 5-19)
TO J13-12 AND J14-2
ON MAIN FRAME (Fig. 5-21)
50 Hz RANGE SELECT
TO CLOCK A2 1 (Fig. 5-19)
TO J13-13 AND J14-3
ON MAIN FRAME (Fig. 5-21)
100 Hz RANGE SELECT
TO CLOCK A2 2 (Fig. 5-19)
TO J13-12 AND J14-4
ON MAIN FRAME (Fig. 5-21)
500 Hz RANGE SELECT
TO CLOCK A2 2
TO J13-11 AND J14-2
ON MAIN FRAME (Fig. 5-21)
1 kHz RANGE SELECT
TO CLOCK A2 3B
TO J14-3B, J13-3B, J15-1B
2 kHz RANGE SELECT
TO CLOCK A2 3A (Fig. 5-19)
TO J13-9, J14-6, AND J15-19
ON MAIN FRAME (Fig. 5-21)
5 kHz RANGE SELECT
TO CLOCK A2 3B (Fig. 5-19)
TO J13-8, J14-22, AND J15-8
TO MAIN FRAME (Fig. 5-21)
10 kHz RANGE SELECT
TO CLOCK A2 1 (Fig. 5-19)
TO J14-8 AND J15-7
ON MAIN FRAME (Fig. 5-21)
20 kHz RANGE SELECT
TO CLOCK A2 1 (Fig. 5-19)
TO J14-24 AND J15-7
ON MAIN FRAME (Fig. 5-21)
50 kHz RANGE SELECT
TO CLOCK A2 2
TO J14-AND J15-12
LOW FROM DIGITAL INDICATOR A12-2 (Fig. 5-5)
1/2 FROM DIGITAL INDICATOR A12-1 (Fig. 5-5)
3/4 FROM DIGITAL INDICATOR A12-8 (Fig. 5-5)
NORMAL FROM DIGITAL INDICATOR A12-7 (Fig. 5-5)
OVERLOAD FROM DIGITAL INDICATOR A12-18 (Fig. 5-5)
TRANSIENT CAPTURE LAMP FROM DISPLAY CONTROL A16-8 (Fig. 5-14)
TRANSIENT CAPTURE SWITCH TO DISPLAY CONTROL A16-9 (Fig. 5-14)
UPDATE LAMP FROM DISPLAY CONTROL A16-14 (Fig. 5-14)
UPDATE SWITCH TO DISPLAY CONTROL A16-15 (Fig. 5-14)
HOLD LAMP FROM DISPLAY CONTROL A16-16 (Fig. 5-14)
HOLD SWITCH TO DISPLAY CONTROL A16-17 (Fig. 5-14)
MARKER ENABLE FROM MARKER GENERATOR A18-8 (Fig. 5-1)
SINGLE/RESET ENABLE FROM MARKER GENERATOR A18-9 (Fig. 5-1)
AUTO ENABLE TO COUNTER CONTROL A17-7 (Fig. 5-18)
TRIGGER INPUT FROM 20 DH MAIN FRAME (Fig. 5-21)
+28V
+12V
+5V
-12V
-28V
LOW
1/2
3/4
NORMAL
OVERLOAD
TRANSIENT CAPTURE
UPDATE
HOLD
FREQUENCY MARKERS
INT
EXT
OFF
MEMORY
AUTO
MEMORY PERIOD
SINGLE RESET
TRANSIENT TRIGGER
SECTION GAIN AND COMPOSITE GAIN
vs
NORMALIZED FREQUENCY
NOTES: UNLESS OTHERWISE INDICATED:
1. RESISTANCE SHOWN IN OHMS
M = MEGOHMS ARE 1/4W ±5%, ±1% ARE 1/8W
M1 = CAPACITORS SHOWN IN MICROFARADS
MB = CAPACITANCE 01 ARE 25V +80% -20%
2. FACTORY SELECT WITH ±TYPICAL VALUES SHOWN.
3. DIODES ARE TYPE 1N914.
4. TRANSISTORS ARE TYPE 2N3862.
5. SYMBOL: INDICATES FRONT PANEL LOCATION
HIGHEST REF DESIG USED
ES2
CR12
C60
C65
TP6
R156
ES6
FRONT PANEL
ASSEMBLY 13712-1
(CKT CARD A22 INPUT ASSY 15048-1)
Figure 5-1




CONDITIONED SIGNAL INPUT
CONDITIONED SIGNAL FROM INPUT ASSEMBLY A32 (E.P. Fig. 5-11 Via Ref. Cal.)
HOLD/TRACK # FROM NUMBER GENERATOR A13-8 (Fig. 5-4)
SAMPLED INPUT SIGNAL
COMPARATOR OUTPUT TO NUMBER GENERATOR A13-6 (Fig. 5-4)
8 TO +5V
6 TO SIGNAL FROM LADDER A14-3 (Fig. 5-3)
+12V
-12V
+28V
+5V
GND

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NOTES:

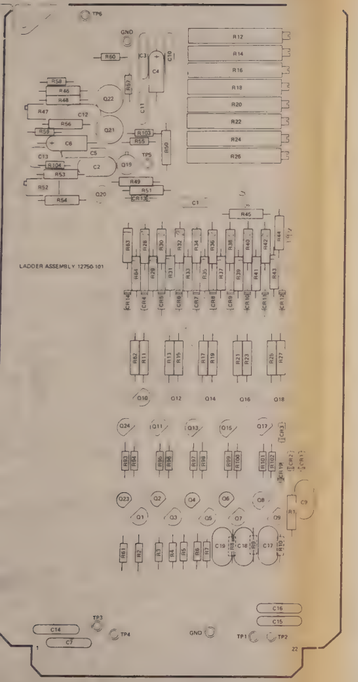
UNLESS OTHERWISE INDICATED,

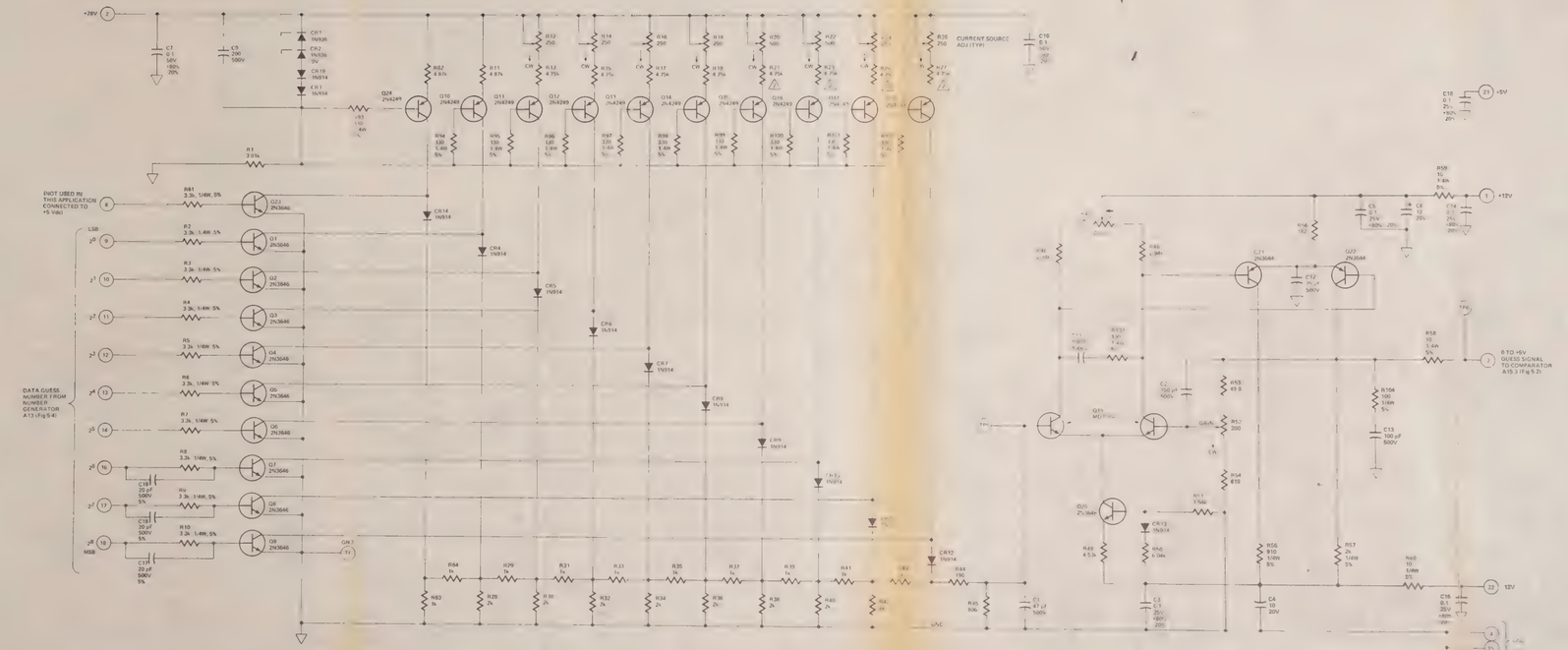
1. RESISTOR VALUES IN OHMS, 1/4W, 5%, AND CAPACITOR VALUES IN MICROFARADS 20%

2. INTEGRATED CIRCUIT TYPES:
   A1: SN7400N GND PIN 7, +5V PIN 14

3. UNUSED PORTIONS OF INTEGRATED CIRCUITS

COMPARATOR
(Assembly 14860-3
Ckt Card A15)
Figure 5-2.



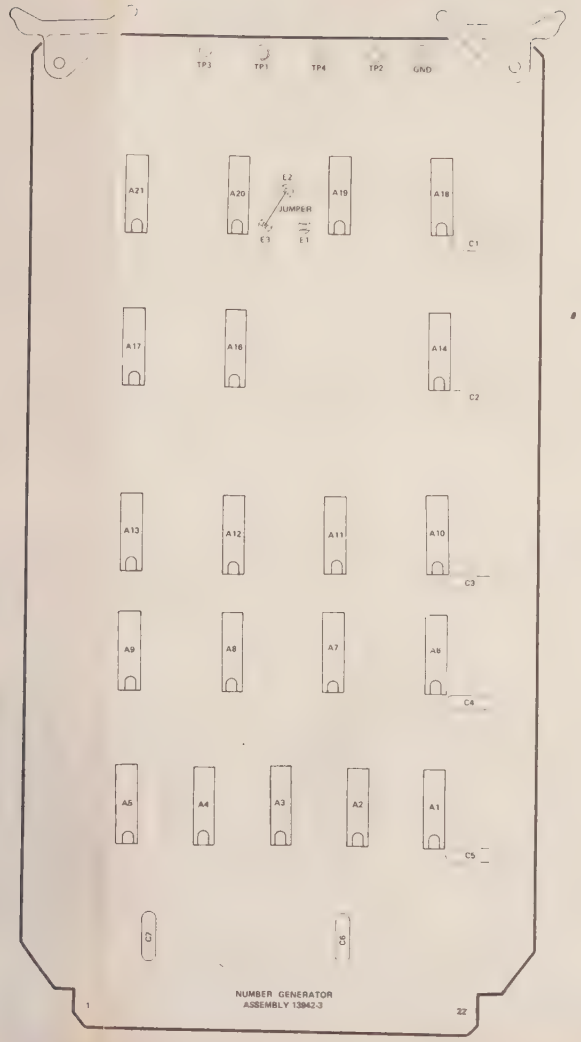


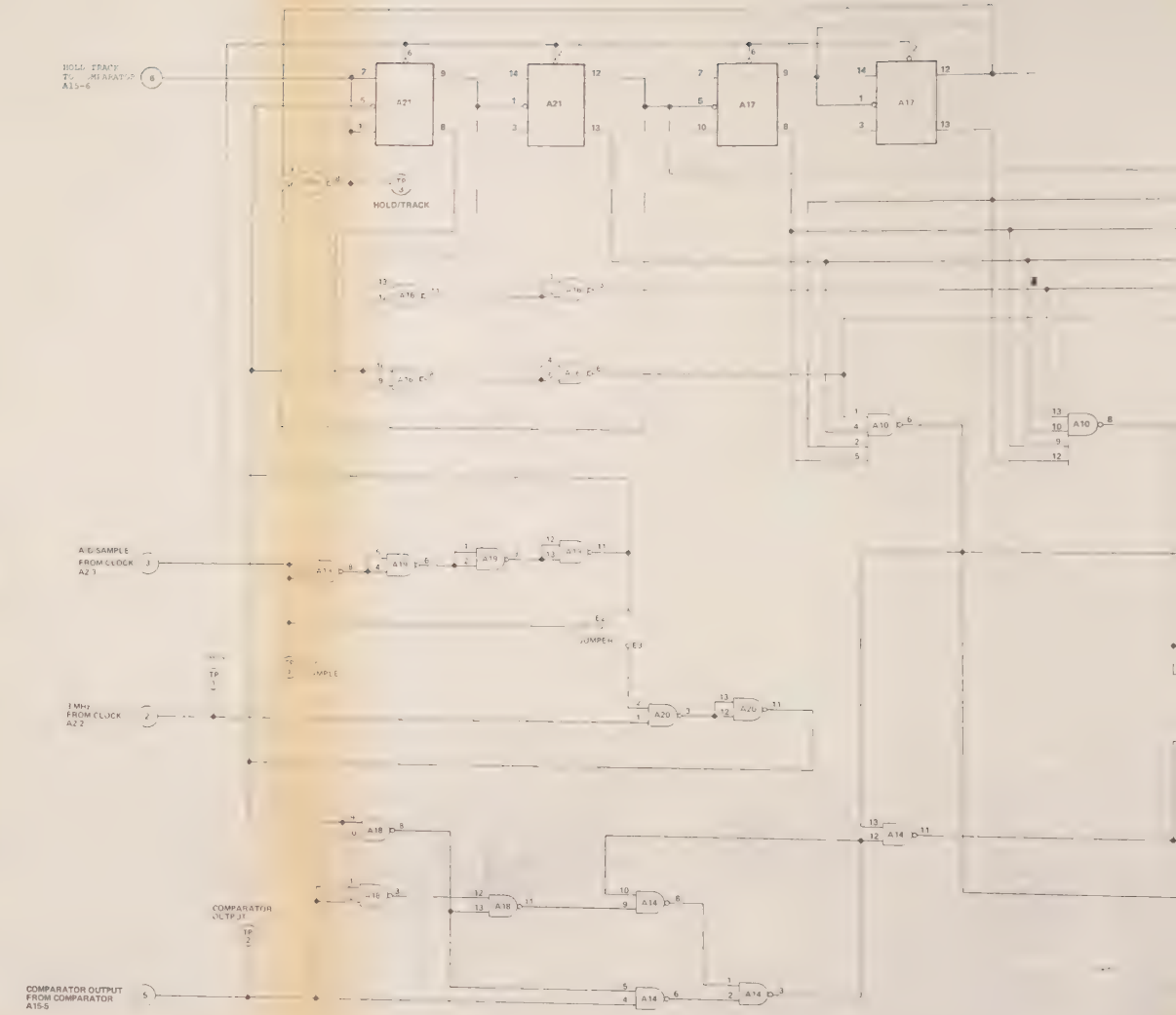
NOTES. UNLESS OTHERWISE INDICATED

1. RESISTOR VALUES ARE IN OHMS, 1/8W, 1% AND CAPACITOR VALUES IN MICROFARADS ±10%

2 FACTORY SELECTED WITH TYPICAL VALUE SHOWN

LADDER
(Assembly 12750-101, Ckt.Card A14)
Figure 5-3.


TP3
TP1
TP4
TP2
GND
A21
A20
E2
JUMPER
E3
E1
A19
A18
C1
A17
A16
A14
C2
A13
A12
A11
A10
C3
A9
A8
A7
A6
C4
A5
A4
A3
A2
A1
C5
C7
C6
NUMBER GENERATOR
ASSEMBLY 13942-3
1
22


HOLD TRACK
TO COMPARATOR
A15-6
A21
A21
A17
A17
TP
HOLD/TRACK
A16
A16
A14
A10
A10
A/D SAMPLE
FROM CLOCK
A2 3
A19
A19
A19
JUMPER
E4
E3
TP
SAMPLE
1MHz
FROM CLOCK
A2 2
A20
A20
A18
A18
A14
A14
COMPARATOR
OUTPUT
TP
COMPARATOR OUTPUT
FROM COMPARATOR
A15-5
A14
A14

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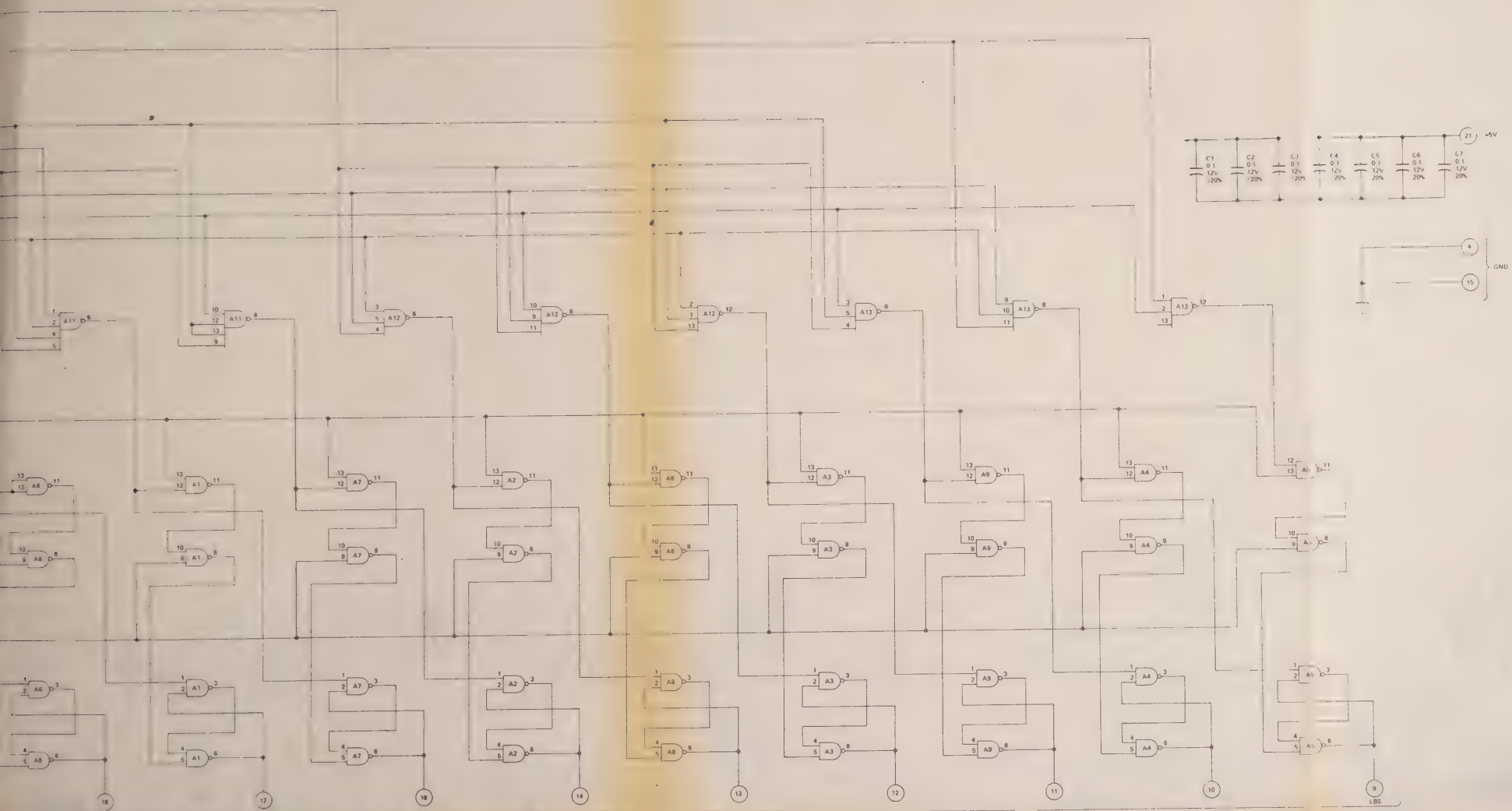
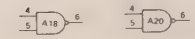


NOTES

1. INTEGRATED CIRCUIT TYPES

REF DESIG	TYPE	GND	+5V
A1	SN7400N	PIN 7	PIN 14
A2	SN7400N	PIN 7	PIN 14
A3	SN7400N	PIN 7	PIN 14
A4	SN7400N	PIN 7	PIN 14
A5	SN7400N	PIN 7	PIN 14
A6	SN7400N	PIN 7	PIN 14
A7	SN7400N	PIN 7	PIN 14
A8	SN7400N	PIN 7	PIN 14
A9	SN7400N	PIN 7	PIN 14
A10	SN7420N	PIN 7	PIN 14
A11	SN7420N	PIN 7	PIN 14
A12	SN7410N	PIN 7	PIN 14
A13	SN7410N	PIN 7	PIN 14
A14	SN7400N	PIN 7	PIN 14
A16	SN7400N	PIN 7	PIN 14
A17	SN7473N	PIN 11	PIN 4
A18	SN7400N	PIN 7	PIN 14
A19	SN7400N	PIN 7	PIN 14
A20	SN7400N	PIN 7	PIN 14
A21	SN7473N	PIN 11	PIN 4

UNUSED PORTIONS OF IC's

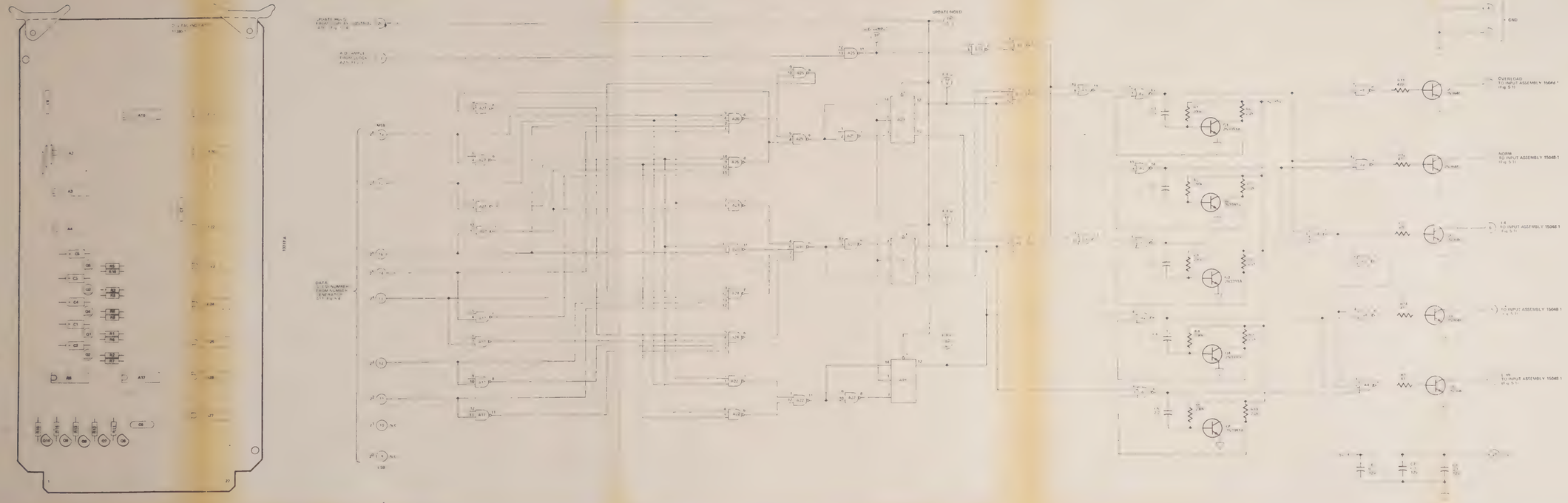


NUMBER GENERATOR

(Assembly 13942-3,

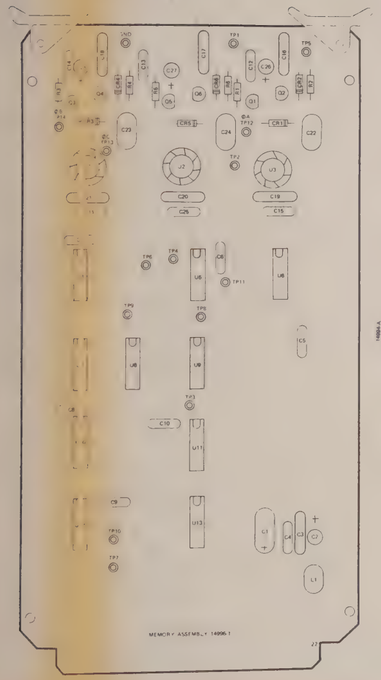
Ckt Card A13)

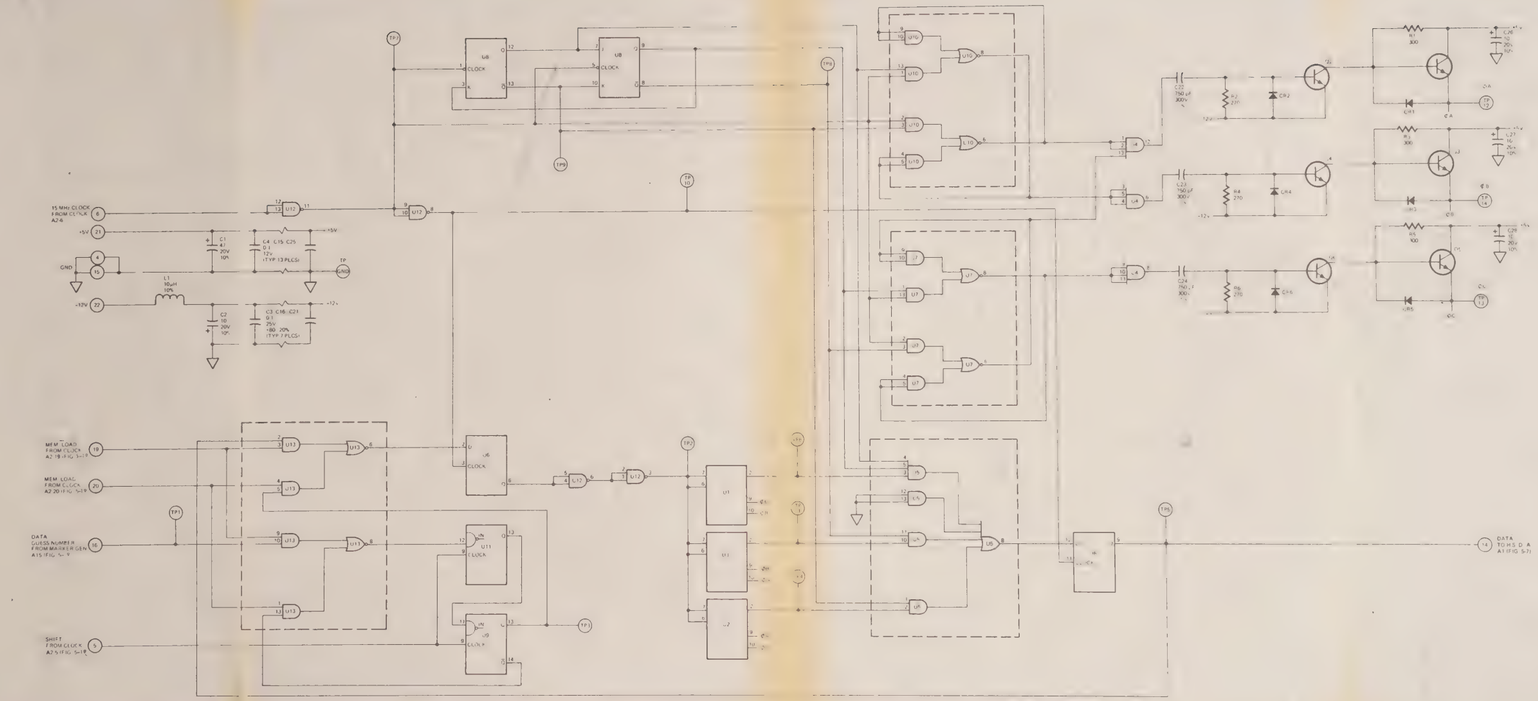
Figure 5-4.



DIGITAL INDICATOR
(Assembly 11380-1,
Ckt Card A12)
Figure 5-5.

PROPRIETARY RIGHTS OF SIGNAL UNIT ... IN PART OR IN WHOLE ... are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose ... and the recipient, by accepting this material, agrees that neither it nor the information contained herein will be reproduced, used in whole or in part for any purpose other than ... nor otherwise disclosed in any manner ... to any person ... except to its ... employees.




15 MHz CLOCK FROM CLOCK A2-6
+5V
GND
+12V
MEM LOAD FROM CLOCK A2-19 (FIG 5-17)
MEM LOAD FROM CLOCK A2-20 (FIG 5-18)
DATA (USED ALWAYS) FROM MASTER GEN A1-5 (FIG 5-9)
SHIFT FROM CLOCK A2-5 (FIG 5-18)
DATA TO M.S.D. A1 (FIG 5-7)

NOTES UNLESS OTHERWISE INDICATED

1. ALL RESISTOR VALUES ARE IN OHMS, 1/8W, 5%
   ALL CAPACITOR VALUES ARE IN MICROFARADS, 12V, 10%
2. DIODES ARE TYPE 1N914
3. INTEGRATED CIRCUIT TYPES

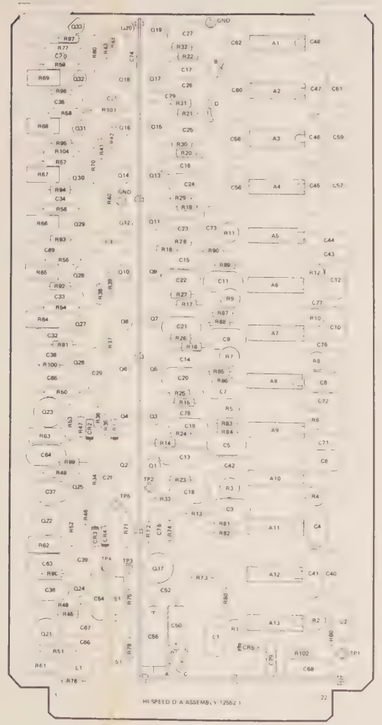
REF DESIG	TYPE	+5V	GND
U1 U2 U3	TI54S121FK		
U4	FAD030	7	3
U5	SN74H02N	14	7
U6	SN74H74N	14	7
U7 U10	SN74S00N	14	7
U8	SN7473N	13	4
U9 U11	SN74S11AN	5	10
U12	SN74H00N	14	7
U13	SN74S51N	14	7

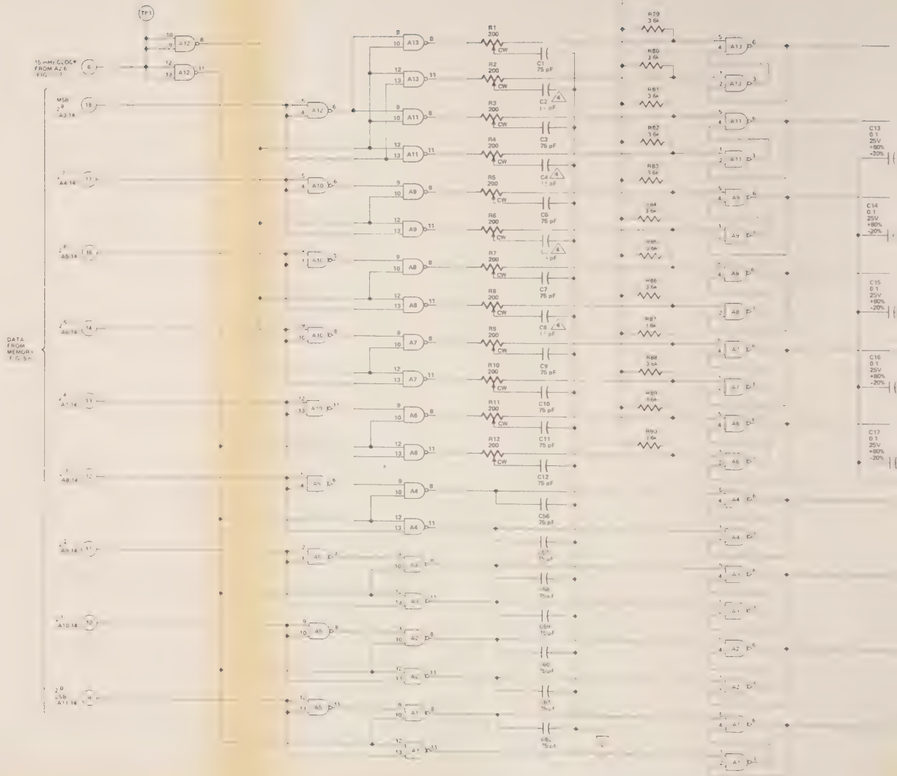
4. TRANSISTORS ARE TYPE 2N5772.

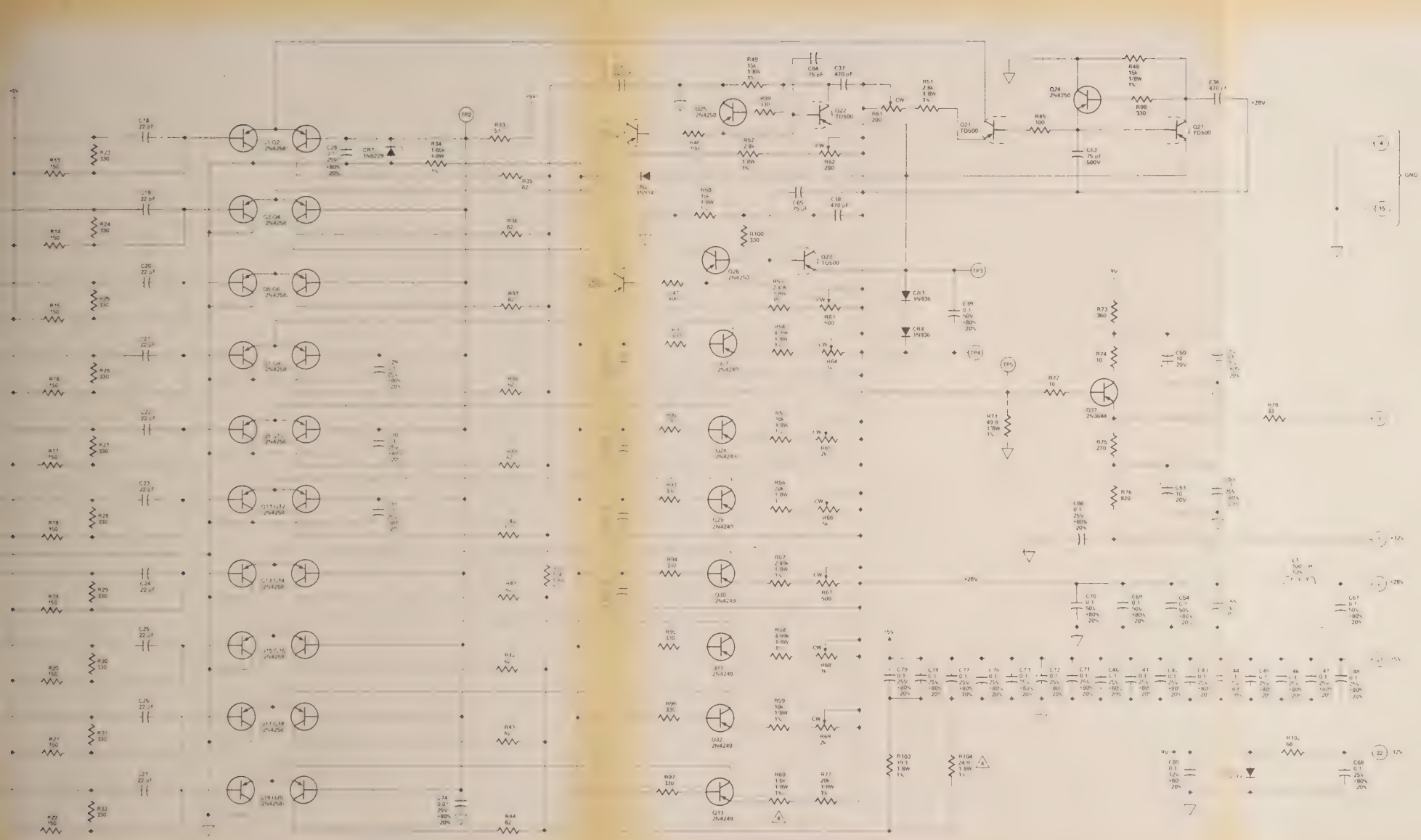
MEMORY ASSEMBLY IS USED IN CIRCUIT CARD LOCATIONS A3 THRU A11. BIT WEIGHTS CONSISTS OF

A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
1	2	4	8	16	32	64	128	256	512	1024

MEMORY
(Assembly 14996-1
Ckt Card A3-A11)
Figure 5-6


HI SPEED D A ASSEMBLY 12562 1
12114 A


15 mHz CLOCK FROM A2 FIG.
MSB A9 A3-14
A4-14
A5-14
A6-14
A7-14
A8-14
A9-14
A10-14
A11-14
DATA FROM MEMORY FIG. 5



NOTES
UNLESS OTHERWISE INDICATED

1 ALL RESISTOR VALUES ARE IN OHMS 1/4W 5% ALL CAPACITANCE IN MICROFARADS 500V 10%

2 INTEGRATED CIRCUIT TYPE

A1	SN 74H00 N	
A2	SN 74H00 N	
A3	SN 74H00 N	
A4	SN 74H00 N	
A5	SN 74H00 N	
A6	SN 74H00 N	GND PIN 7
A7	SN 74H00 N	+5V PIN 14
A8	SN 74H00 N	
A9	SN 74H00 N	
A10	SN 74H00 N	
A11	SN 74H00 N	
A12	SN 74H00 N	
A13	SN 74H00 N	

3 PORTION OF INTEGRATED CIRCUIT NOT USED

4 FACTORY SELECTED WITH TYPICAL VALUE SHOWN

HIGH-SPEED D/A
(Assembly 12552-1,
Ckt. Card A1)
Figure 5-7.

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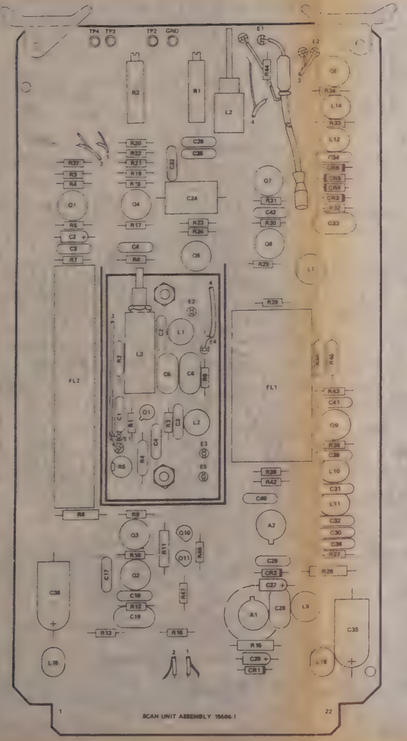

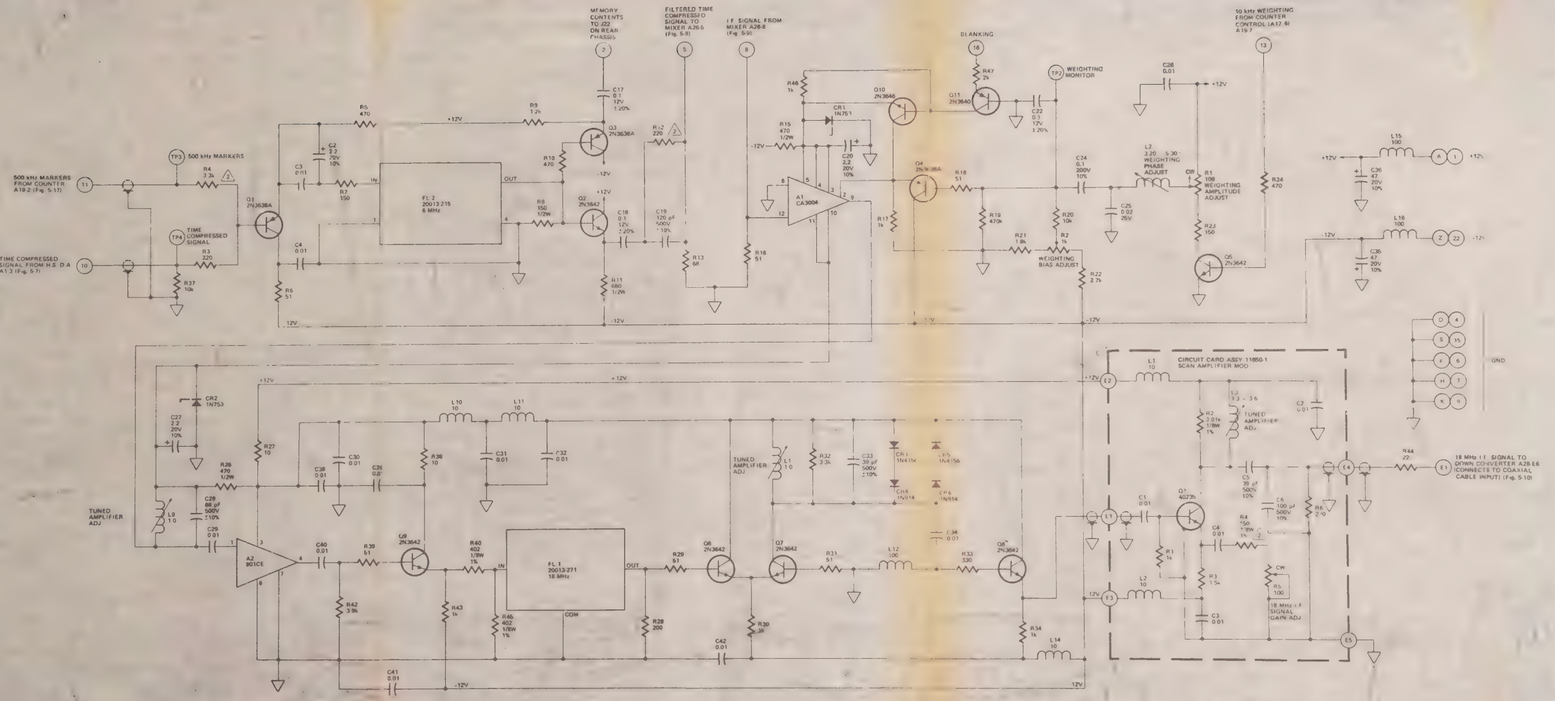
MEMORY CONTENTS TO J22 ON REAR CHASSIS
FILTERED TIME COMPRESSED SIGNAL TO MIXER A26-5 (Fig. 5-5)
I.F. SIGNAL FROM MIXER A28-8 (Fig. 5-5)
BLANKING
WEIGHTING MONITOR
50 kHz WEIGHTING FROM COUNTER CONTROL (A17-8) A19-7
500 kHz MARKERS FROM COUNTER A19-2 (Fig. 5-17)
TIME COMPRESSED SIGNAL FROM H.S. D.A. A13 (Fig. 5-7)
TP3 500 kHz MARKERS
TP4 TIME COMPRESSED SIGNAL
FL3 2503-215 6 MHz
FL2 2013-271 18 MHz
A1 CA3094
A2 9013CE
WEIGHTING BIAS ADJUST
WEIGHTING PHASE ADJUST
WEIGHTING AMPLITUDE ADJUST
TUNED AMPLIFIER ADJ.
CIRCUIT CARD ASSY 11856-1 SCAN AMPLIFIER MOD
18 MHz I.F. SIGNAL TO DOWN CONVERTER A28-E6 CONNECTED TO COAXIAL CABLE INPUT) (Fig. 5-10)
18 MHz I.F. SIGNAL GAIN ADJ
GND

NOTES: UNLESS OTHERWISE INDICATED

1. ALL RESISTOR VALUES ARE IN OHMS 1/8W 5% AND CAPACITOR VALUES IN MICROFARADS. 25V -80 20% AND INDUCTOR VALUES IN MICROHENRIES 10%.

(2) FACTORY SELECTED WITH TYPICAL VALUE SHOWN.

SCAN UNIT
(Assembly 15586-1,
Ckt Card A27)
Figure 5-8.

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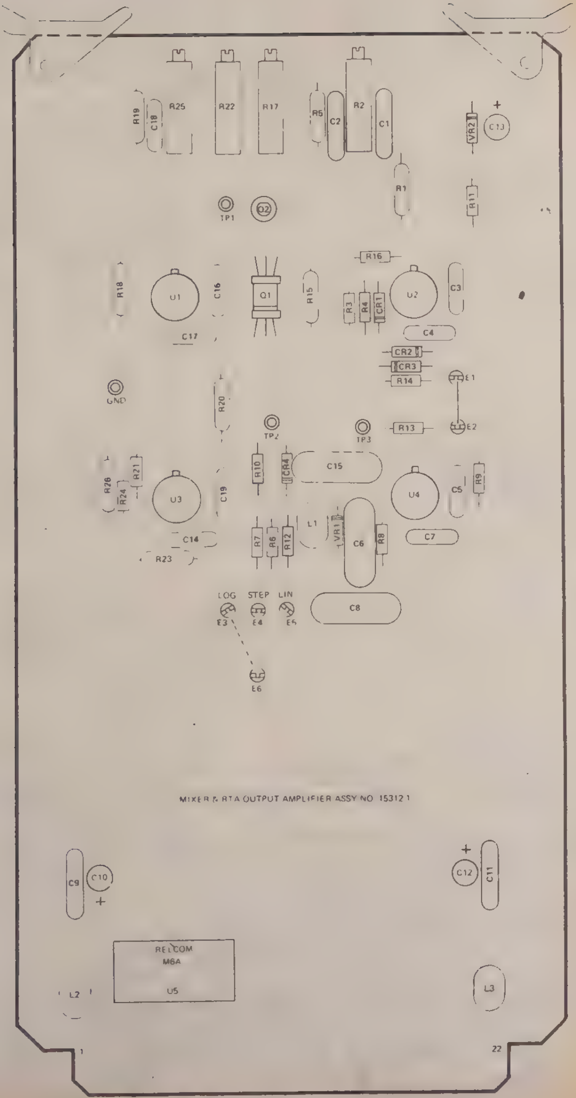
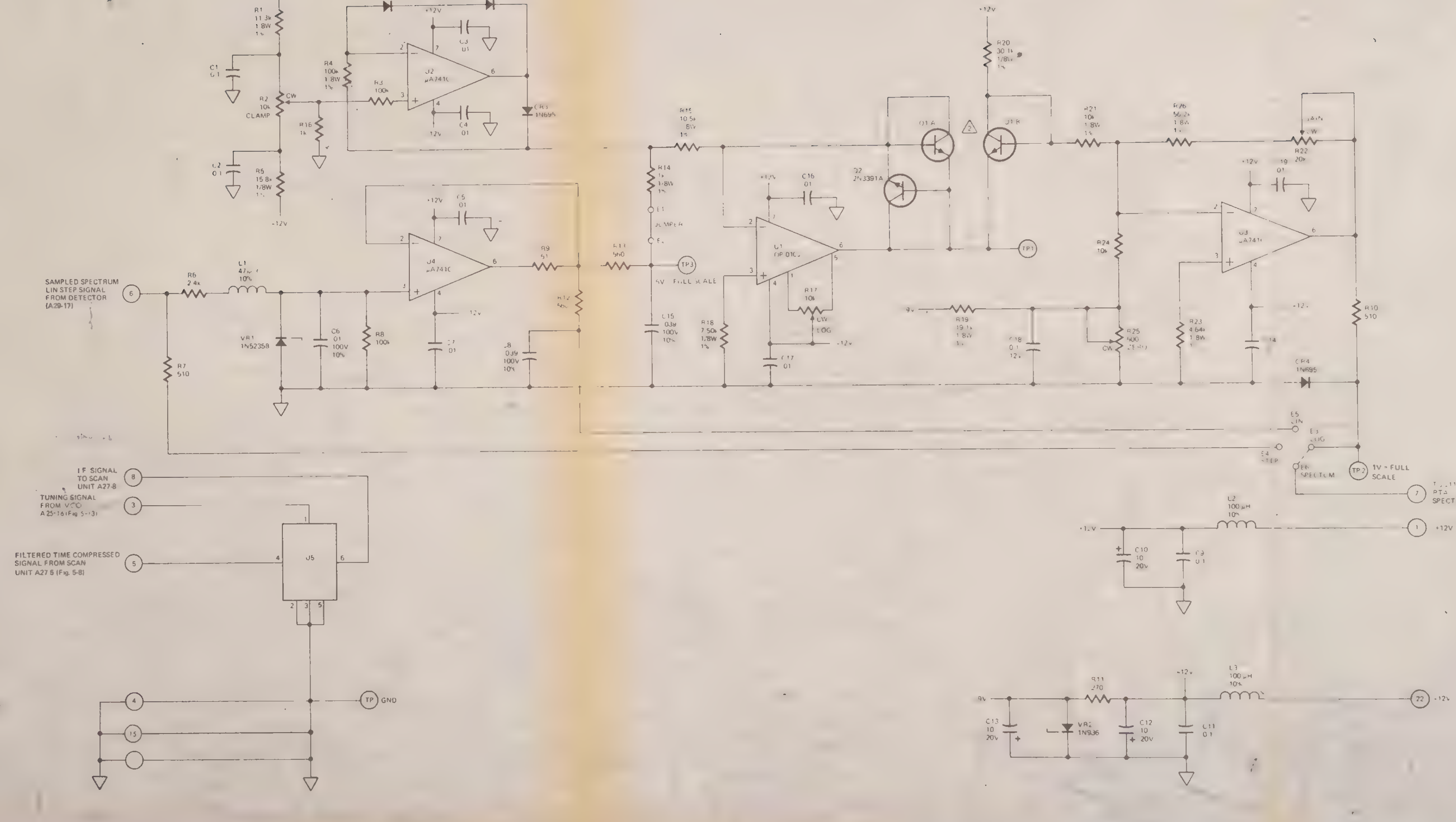


R19 C18 R25 R22 R17 R5 C2 R2 C1 VR2 C13
R1 R11
TP1 Q2
R16
R18 U1 C16 Q1 R15 R3 R4 CR1 U2 C3
C17 C4
CR2 CR3 R14 E1
GND R20
TP2 TP3 R13 E2
R26 R24 R21 U3 C19 R10 CR4 C15 U4 C5 R9
C14 R7 R6 R12 L1 VR1 C6 R8 C7
R23
LOG STEP LIN
E3 E4 E5 C8
E6
MIXER & RTA OUTPUT AMPLIFIER ASSY NO 15312 1
C9 C10 C12 C11
RELCOM M6A U5
L2 L3
1 22



SAMPLED SPECTRUM LIN STEP SIGNAL FROM DETECTOR (A29-17)
I F SIGNAL TO SCAN UNIT A27-8
TUNING SIGNAL FROM VCO A 25-16 (Fig 5-13)
FILTERED TIME COMPRESSED SIGNAL FROM SCAN UNIT A27 5 (Fig. 5-8)
R1 11.3k 1/8W 1%
R2 10k CLAMP
R5 15.8k 1/8W 1%
CR1 1N914
CR2 1N914
CR3 1N695
U2 μA741C
U4 μA741C
U1 OP 01C
U3 μA741C
Q1A Q1B
Q2 2N3391A
R20 30.1k 1/8W 1%
R22 20k GAIN
R25 500 ZERO
VR1 1N5235B
VR2 1N936
CR4 1N695
TP1 TP2 TP3 GND
5V FULL SCALE
1V = FULL SCALE
RTA SPECTRUM
E5 LIN E3 LOG E4 STEP E6 SPECTRUM
L2 100 μH 10%
L3 100 μH 10%
+12V
U5

NOTES

1 UNLESS OTHERWISE INDICATED, RESISTOR VALUES ARE IN OHMS, 1/4W, 5%, AND CAPACITOR VALUES IN MICROFARADS, 25V, +80 -20%.

2 MATCHED PAIR PER SDC SPEC 20013-04

MIXER & RTA
OUTPUT AMPLIFIER
(Assembly 15312-1
Ckt Card A26)
Figure 5-9

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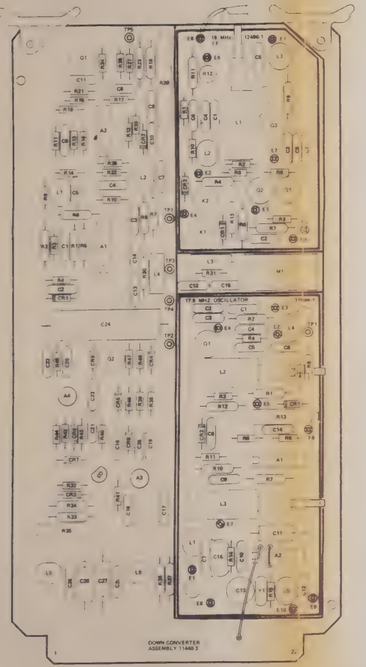

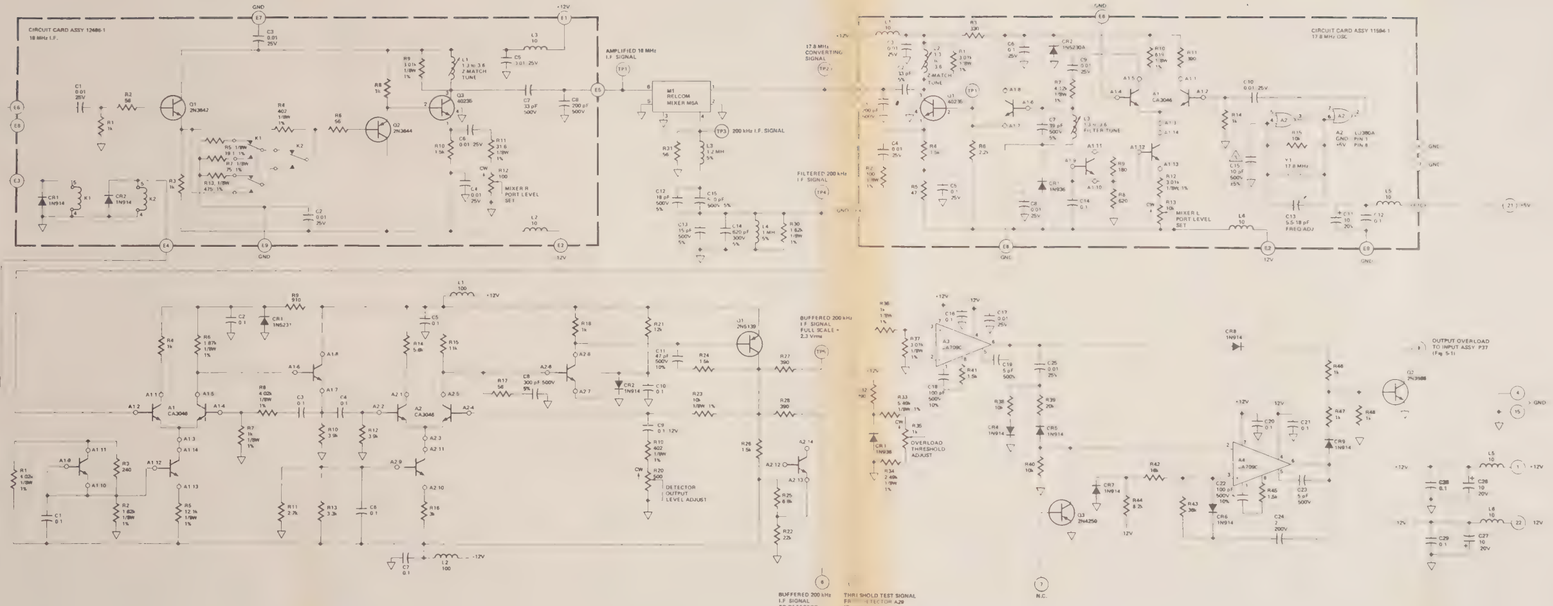
CIRCUIT CARD ASSY 12486-1
18 MHz I.F.
18 MHz I.F. SIGNAL FROM SCAN UNIT A27 (Fig. 5-8)
AMPLIFIED 18 MHz I.F. SIGNAL
MIXER R PORT LEVEL SET
17.8 MHz CONVERTING SIGNAL
200 kHz I.F. SIGNAL
FILTERED 200 kHz I.F. SIGNAL
CIRCUIT CARD ASSY 11584-1
17.8 MHz OSC.
MIXER L PORT LEVEL SET
+10 OR +26 dB GAIN FROM INPUT ASSY J27 (Fig. 5-5)
+20 OR +26 dB GAIN FROM INPUT ASSY J26-1 (Fig. 5-5)
BUFFERED 200 kHz I.F. SIGNAL FULL SCALE = 2.3 Vrms
DETECTOR OUTPUT LEVEL ADJUST
BUFFERED 200 kHz I.F. SIGNAL TO DETECTOR A29 (Fig. 5-11)
THRESHOLD TEST SIGNAL TO DETECTOR A29 (Fig. 5-11)
OVERLOAD THRESHOLD ADJUST
OUTPUT OVERLOAD TO INPUT ASSY P37 (Fig. 5-5)
N.C.

NOTES:

1. UNLESS OTHERWISE INDICATED RESISTOR VALUES ARE IN OHMS 1/4W 5% AND CAPACITOR VALUES IN MICROFARADS 12V.
2. INDUCTOR VALUES IN MICROHENRIES, ±10%.
3. FACTORY SELECT WITH TYPICAL VALUE SHOWN.
4. PORTION OF INTEGRATED CIRCUIT NOT USED ASSEMBLY 11584-1.

DOWN CONVERTER
(Assembly 11440-3, Ckt Card A28)
Figure 5-10.

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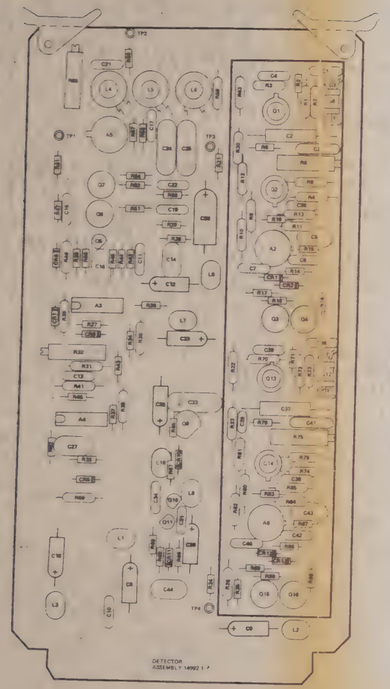
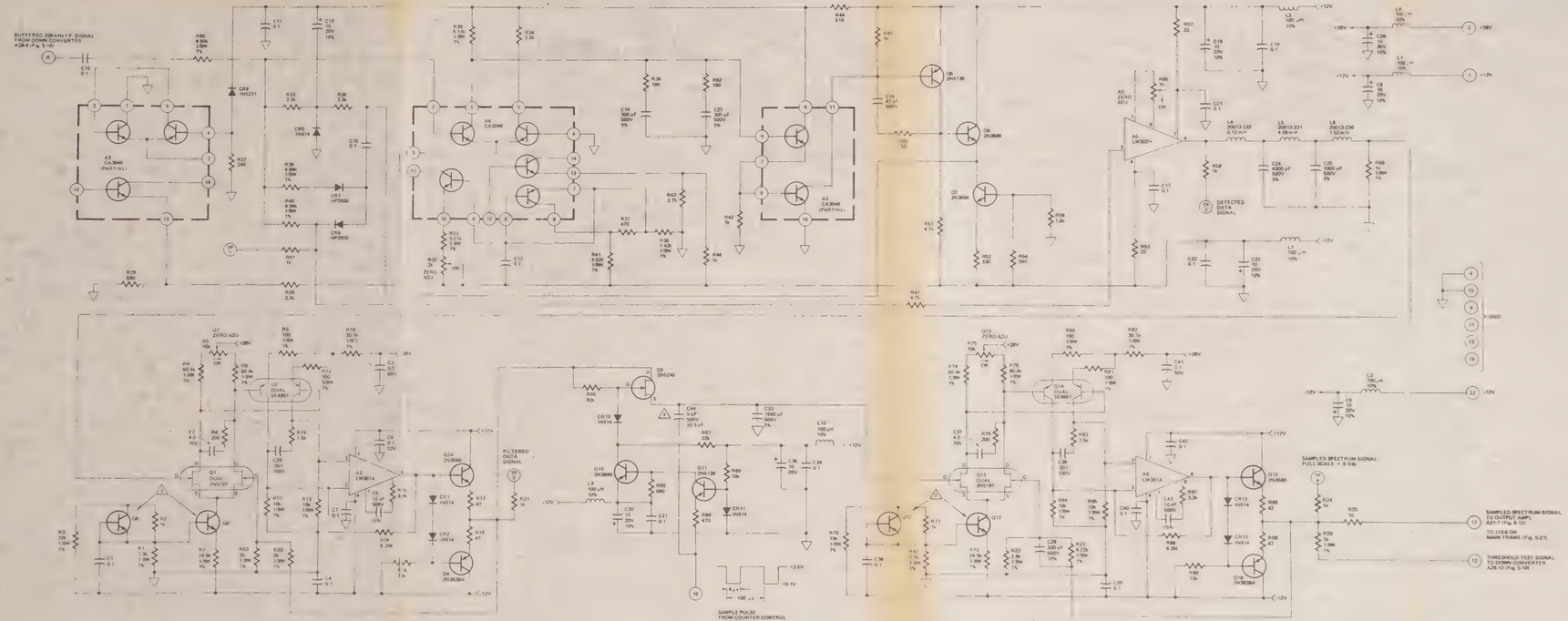
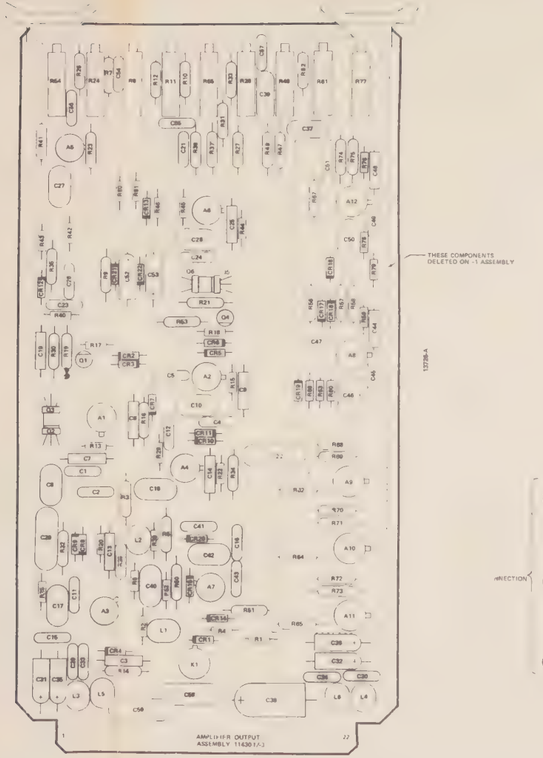


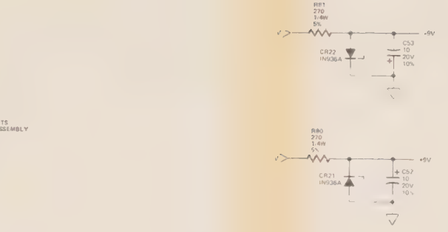

BUFFERED 200 kHz I.F. SIGNAL FROM DOWN CONVERTER A28-4 (Fig. 5-10)
A3 CA3046 (PARTIAL)
A4 CA3046
A3 CA3046 (PARTIAL)
ZERO ADJ
A5 LM302H
DETECTED DATA SIGNAL
A6 ZERO ADJ
A6 LM301A
SAMPLED SPECTRUM SIGNAL FULL SCALE = 8 Vdc
SAMPLED SPECTRUM SIGNAL TO OUTPUT AMPL A23-7 (Fig. 5-12)
TO J13-8 ON MAIN FRAME (Fig. 5-21)
THRESHOLD TEST SIGNAL TO DOWN CONVERTER A28-12 (Fig. 5-10)
U1 ZERO ADJ
U2 DUAL LF4901
Q1 DUAL 2N5197
A2 LM301A
FILTERED DATA SIGNAL
SAMPLE PULSE FROM COUNTER CONTROL A17-7 (Fig. 5-19)
Q13 ZERO ADJ
Q14 DUAL LF4901
Q13 DUAL 2N5197
A6 LM301A
GND

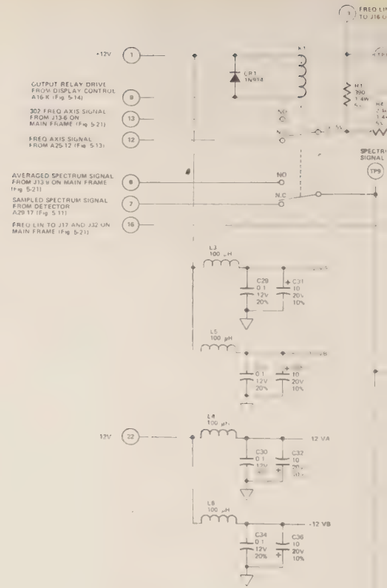
NOTES: UNLESS OTHERWISE INDICATED:

1. RESISTOR VALUES ARE IN OHMS, 1/4W, 5%, AND CAPACITOR VALUES ARE IN MICROFARADS, 10V ±20%.
2. MATCHED PAIR PER 200013-045 (2N3391A).
3. FACTORY ADJUST WITH TYPICAL VALUE SHOWN.

DETECTOR
(Assembly 14992-1
Ckt Card A29)
Figure 5-11.


THESE COMPONENTS DELETED ON -1 ASSEMBLY
13739-A
AMPLIFIER OUTPUT ASSEMBLY 11430-1/-3


R81 270 1.4W 5%
CR22 1N4004
+8V
C53 10 20V 10%
R80 270 1.4W 5%
CR21 1N4004
+8V
C52 10 20V 10%
CR14 1N914
CR15 1N914
+12 VB
C41 0.1
500V 10%
R50 100k
R51 100k
R48 5K
CW
μA709C
C43 0.01
R52 5.11k 1%
12 VB
C40 510 μF 100V 5%
CR20 1N695
+12 VB
C35 100 15V 10%
R42 511 1%
C39 0.1
R49 12.1k 1%
1N149
DIRECTION


+12V
GUTPUT RELAY DRIVE FROM DISPLAY CONTROL A16 (Fig 5-14)
302 FREQ AXIS SIGNAL FROM J13-6 ON MAIN FRAME (Fig 5-21)
FREQ AXIS SIGNAL FROM A25-12 (Fig 5-13)
AVERAGED SPECTRUM SIGNAL FROM J13-9 ON MAIN FRAME (Fig 5-21)
SAMPLED SPECTRUM SIGNAL FROM DETECTOR A29-17 (Fig 5-11)
FREQ LIN TO J17 AND J32 ON MAIN FRAME (Fig 5-21)
CR1 1N914
R1 390 2.4W
N.O
N.C
L2 100 μH
C29 0.1 12V 20%
C31 10 20V 10%
L5 100 μH
C33 0.1 12V 20%
C35 10 20V 10%
17V
L4 100 μH
C30 0.1 12V 20%
C32 10 20V 10%
12 VA
L6 100 μH
C34 0.1 12V 20%
C36 10 20V 10%
-12 VB
SPECTRUM LIN STEP

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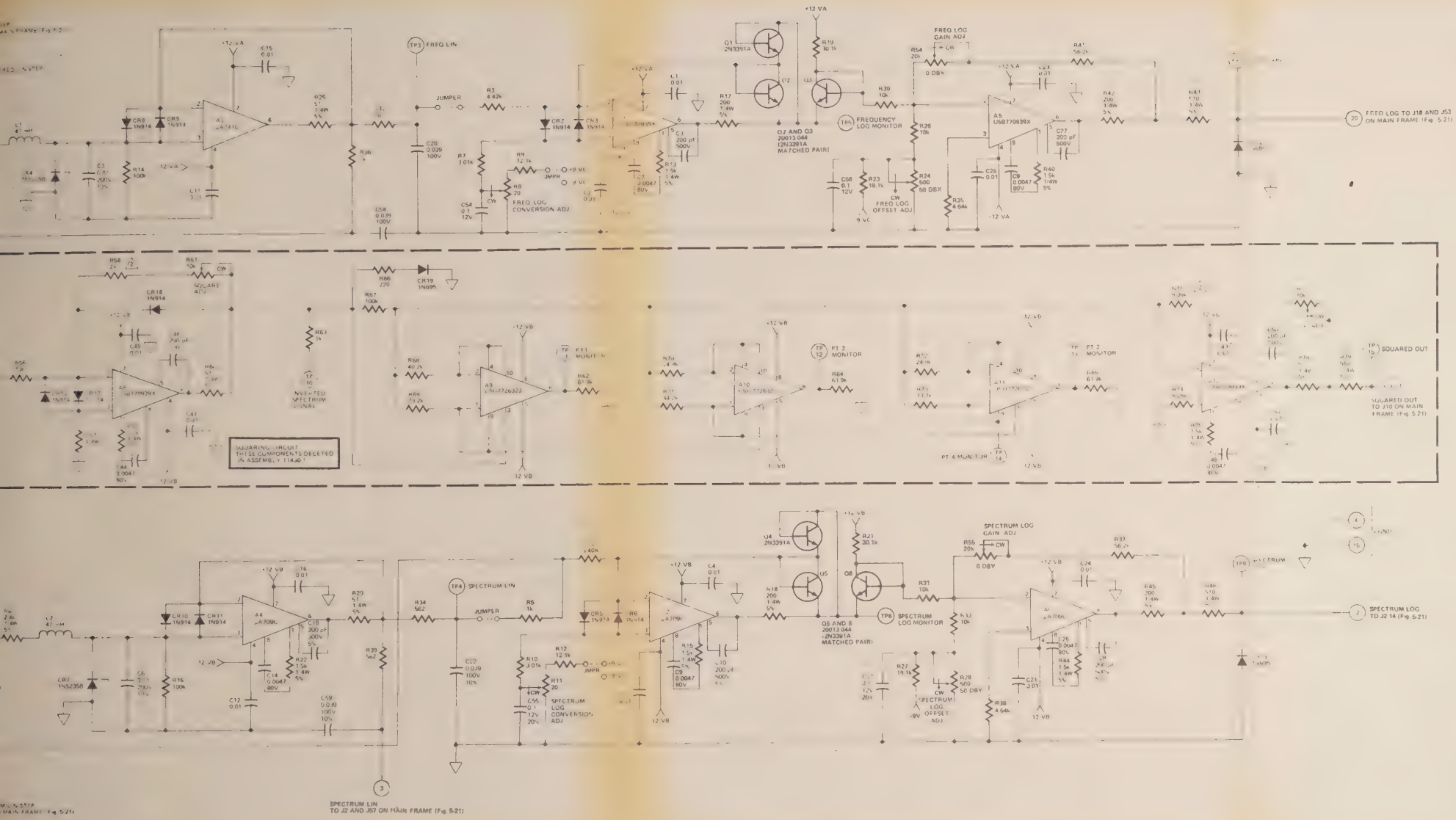
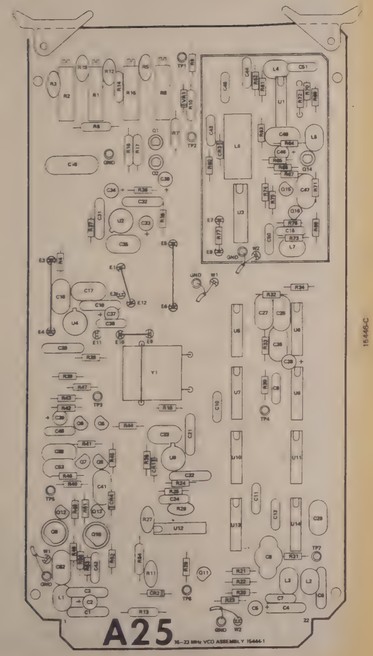
NOTES: UNLESS OTHERWISE INDICATED

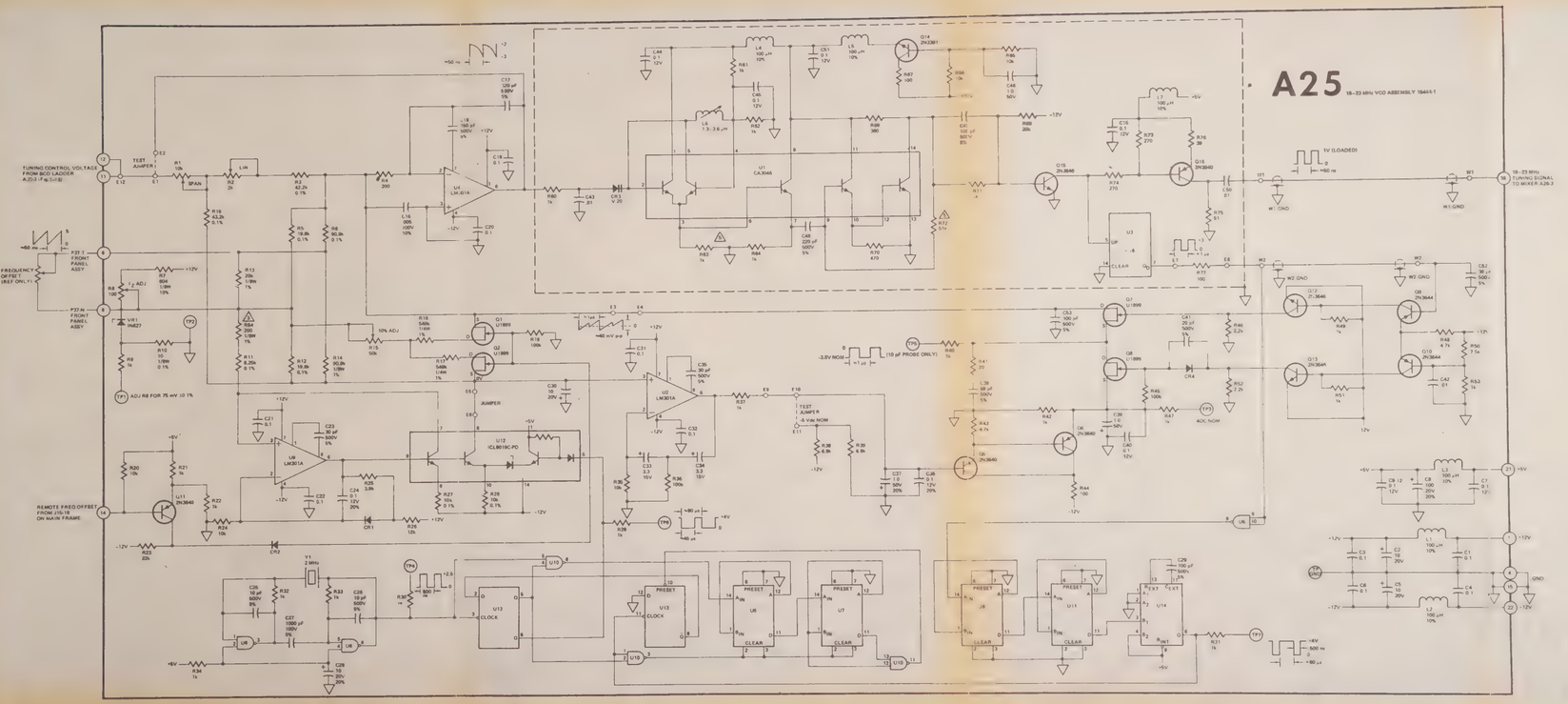
ALL RESISTOR VALUES ARE IN OHMS, 1/8W 1%
ALL CAPACITOR VALUES ARE IN MICROFARADS 25V +80 -20%

△ FACTORY SELECT WITH TYPICAL VALUE SHOWN


FREQ LIN
JUMPER
FREQ LOG CONVERSION ADJ
FREQUENCY LOG MONITOR
Q2 AND Q3 20013 044 (2N3391A MATCHED PAIR)
FREQ LOG GAIN ADJ
FREQ LOG OFFSET ADJ
FREQ LOG TO J18 AND J53 ON MAIN FRAME (Fig. 5-21)
SQUARING CIRCUIT (THESE COMPONENTS DELETED IN ASSEMBLY 11430)
INVERTED SPECTRUM SIGNAL
PT 1 MONITOR
PT 2 MONITOR
PT 3 MONITOR
PT 4 MONITOR
SQUARED OUT
SQUARED OUT TO J10 ON MAIN FRAME (Fig. 5-21)
SPECTRUM LIN
SPECTRUM LOG CONVERSION ADJ
SPECTRUM LOG MONITOR
Q5 AND 6 20013 044 (2N3391A MATCHED PAIR)
SPECTRUM LOG GAIN ADJ
SPECTRUM LOG OFFSET ADJ
SPECTRUM LOG TO J2 14 (Fig. 5-21)
SPECTRUM LIN TO J2 AND J57 ON MAIN FRAME (Fig. 5-21)

OUTPUT AMPLIFIER
(Assembly 11430-1/-3, Ckt Card A21)
Figure 5-12.





NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS.
   (b) RESISTORS ARE 1/4W, ±5%.
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS @ 25V, +80 -20%.
2. DIODES ARE TYPE 1N914.

△1 FACTORY ADJUST WITH TYPICAL VALUE SHOWN.

△2 ADJUST, IF NECESSARY FOR 5V-AMETRICAL SQUARE WAVE AT COLLECTOR OF Q15.

△3 ADJUST, IF NECESSARY SO 5V P-P SWING MAY BE OBTAINED AT E2.

INTEGRATED CIRCUITS

REF. DESIG.	PART NO.	PWR PINS GND	PWR PINS VCC	UNUSED CIRCUITS
U3	SN74193N	8	16	NONE
U5,U7,U8 & U11	SN7486N	5	10	NONE
U6	SN7400N	7	14	D
U10	SN7400N	7	14	C
U13	SN7474N	7	14	NONE
U14	SN74123N	7	16	NONE

HIGHEST REF DESIG. USED

C53
CR4
E12
L7
Q18
R77
TP7
U18
VR1
W2
Y1

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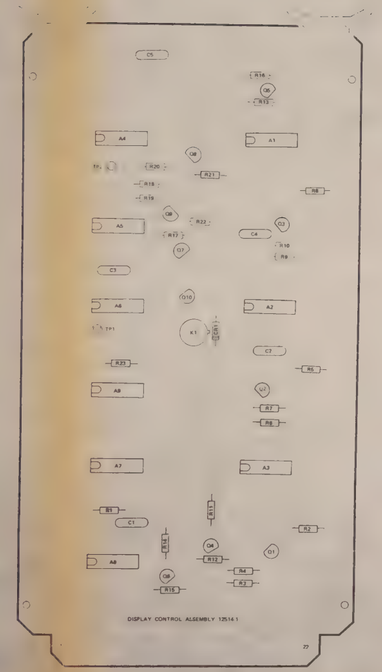
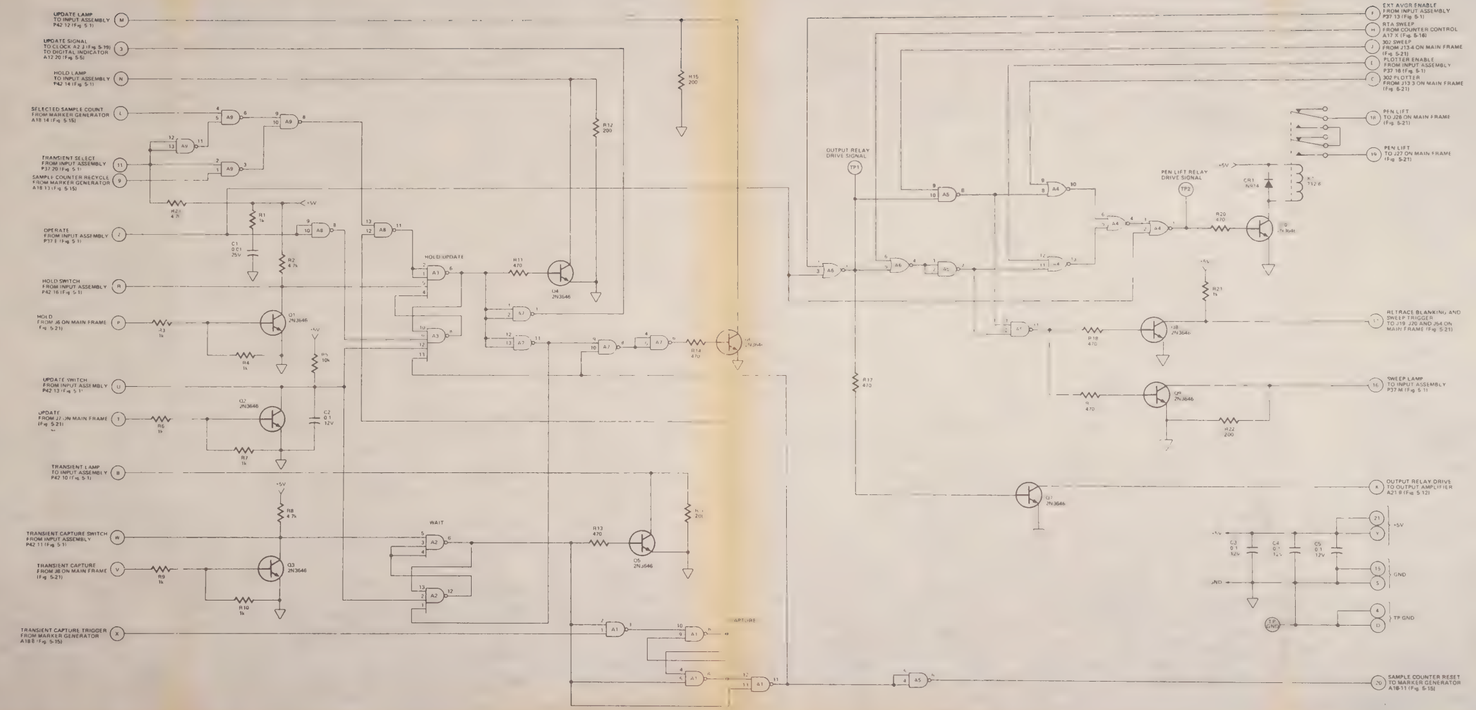
18-23 MHz VCO
(Assembly 15444-1
Ckt Card A25)
Figure 5-13




UPDATE LAMP TO INPUT ASSEMBLY P42 12 (Fig. 5-11)
UPDATE SIGNAL TO CLOCK A2 J (Fig. 5-19) FROM MARKER GENERATOR A17 J10 (Fig. 5-16)
HOLD LAMP TO INPUT ASSEMBLY P42 14 (Fig. 5-11)
SELECTED SAMPLE COUNT FROM MARKER GENERATOR A18 14 (Fig. 5-15)
TRANSIENT SELECT FROM INPUT ASSEMBLY P37 29 (Fig. 5-11)
SAMPLE COUNTER RECYCLE FROM MARKER GENERATOR A18 13 (Fig. 5-15)
OPERATE FROM INPUT ASSEMBLY P37 F (Fig. 5-11)
HOLD SWITCH FROM INPUT ASSEMBLY P42 16 (Fig. 5-11)
HOLD FROM J6 ON MAIN FRAME (Fig. 5-21)
UPDATE SWITCH FROM INPUT ASSEMBLY P42 13 (Fig. 5-11)
UPDATE FROM J2 ON MAIN FRAME (Fig. 5-21)
TRANSIENT LAMP TO INPUT ASSEMBLY P42 10 (Fig. 5-11)
TRANSIENT CAPTURE SWITCH FROM INPUT ASSEMBLY P42 11 (Fig. 5-11)
TRANSIENT CAPTURE FROM J8 ON MAIN FRAME (Fig. 5-21)
TRANSIENT CAPTURE TRIGGER FROM MARKER GENERATOR A18 E (Fig. 5-15)
HOLD/UPDATE
WAIT
CAPTURE
OUTPUT RELAY DRIVE SIGNAL
PEN LIFT RELAY DRIVE SIGNAL
EXT AVGR ENABLE TO INPUT ASSEMBLY P37 28 (Fig. 5-11)
RTA SWEEP FROM COUNTER CONTROL A17 X (Fig. 5-16)
302 SWEEP FROM 213.4 ON MAIN FRAME (Fig. 5-21)
PLOTTER ENABLE TO INPUT ASSEMBLY P37 18 (Fig. 5-11)
302 PLOTTER FROM 213.3 ON MAIN FRAME (Fig. 5-21)
PEN LIFT TO J28 ON MAIN FRAME (Fig. 5-21)
PEN LIFT TO J27 ON MAIN FRAME (Fig. 5-21)
RETRACE BLANKING AND TO J19 AND J24 ON MAIN FRAME (Fig. 5-21)
SWEEP LAMP TO INPUT ASSEMBLY P37 M (Fig. 5-11)
OUTPUT RELAY DRIVE TO OUTPUT AMPLIFIER A21 R (Fig. 5-12)
+5V
GND
TP GND
SAMPLE COUNTER RESET TO MARKER GENERATOR A18 11 (Fig. 5-15)

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NOTES

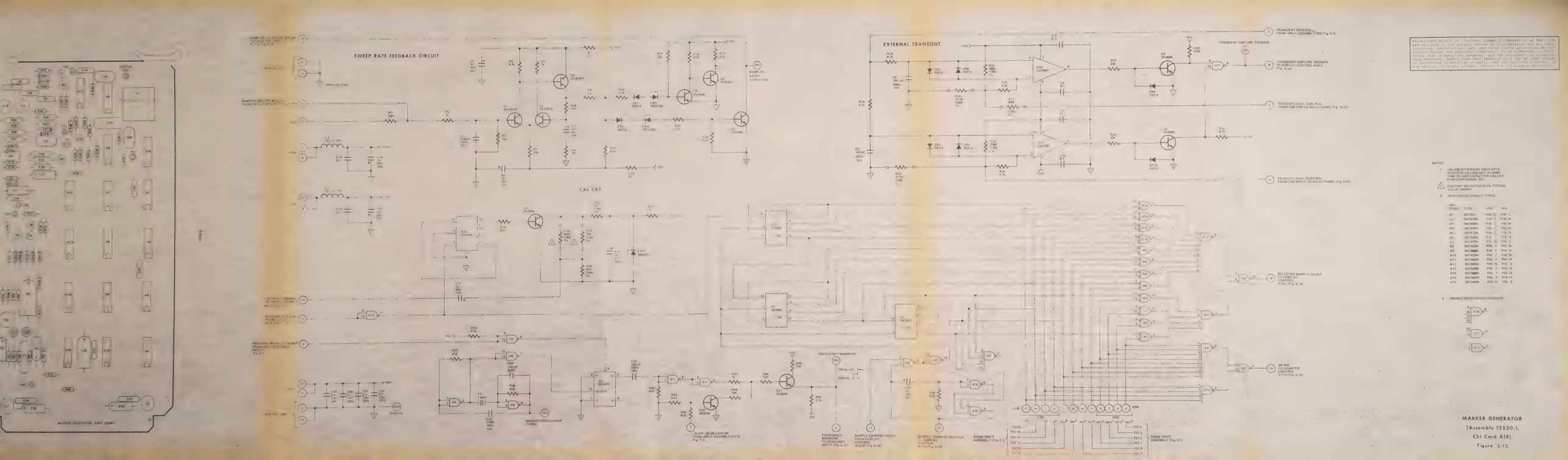
1. UNLESS OTHERWISE INDICATED RESISTOR VALUES ARE IN OHMS FROM 5% TO 10% TOLERANCES IN MICROFARADS TOLERANCES NOT CRITICAL.

INTEGRATED CIRCUIT TYPES

REF DESIG	TYPE	+5V	GND
A1	SN7400N	14	7
A2	SN7410N	14	7
A3	SN7429N	14	7
A4	SN7402N	14	7
A5	SN7408N	14	7
A6	SN7403N	14	7
A7	SN7400N	14	7
A8	SN7400N	14	7

MISC INTEGRATED CIRCUIT

DISPLAY CONTROL
(Assembly 12514-1, Ckt Card A16)
Figure 5-14.


SWEEP RATE FEEDBACK CIRCUIT
CAL CKT
EXTERNAL TRANSIENT
TRANSIENT CAPTURE TRIGGER
FREQUENCY MARKERS
MARKER OSCILLATOR 15 MHz
MARKER GENERATOR ASSY 12520-1
DIGITAL
ANALOG
TRANSIENT TRIGGER TO/FROM INPUT ASSEMBLY P23 (Fig 5-5)
TRANSIENT CAPTURE TRIGGER TO DISPLAY CONTROL A16.5 (Fig 5-14)
TRIGGER LEVEL CONT. R.H. FROM R38 CCW ON MAIN FRAME (Fig 5-21)
TRIGGER LEVEL CONTROL FROM R38 WIPER (W) MAIN FRAME (Fig 5-21)
SELECTED SAMPLE COUNT TO COUNTER CONTROL A10-L (Fig 5-14)
SW 000 TO COUNTER CONTROL A17-B (Fig 5-16)
FREQUENCY MARKERS TO SCAN UNIT A27.11 (Fig 5-8)
SAMPLE COUNTER RESET TO DISPLAY CONTROL A15.20 (Fig 5-14)
SAMPLE COUNTER RECYCLE TO DISPLAY CONTROL A 9.9 (Fig 5-14)
FROM INPUT ASSEMBLY (Fig 5-5)
FROM INPUT ASSEMBLY (Fig 5-5)
SAMPLED LEVEL VARIATION
SAMPLED SPECTRAL MEAS FROM DETECTOR A23
ANALOG GND
DIGITAL GND
+5V
+12V
-12V
-15V
+15V
+127V
+32V
+17V
MSD
LSD

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NOTES

1 UNLESS OTHERWISE INDICATED RESISTOR VALUES ARE IN OHMS, 1/4W 5% AND CAPACITOR VALUES IN MICROFARADS, 20V.

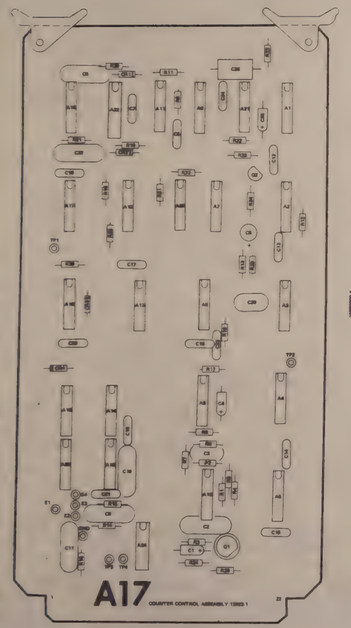
△1 FACTORY SELECTED WITH TYPICAL VALUE SHOWN

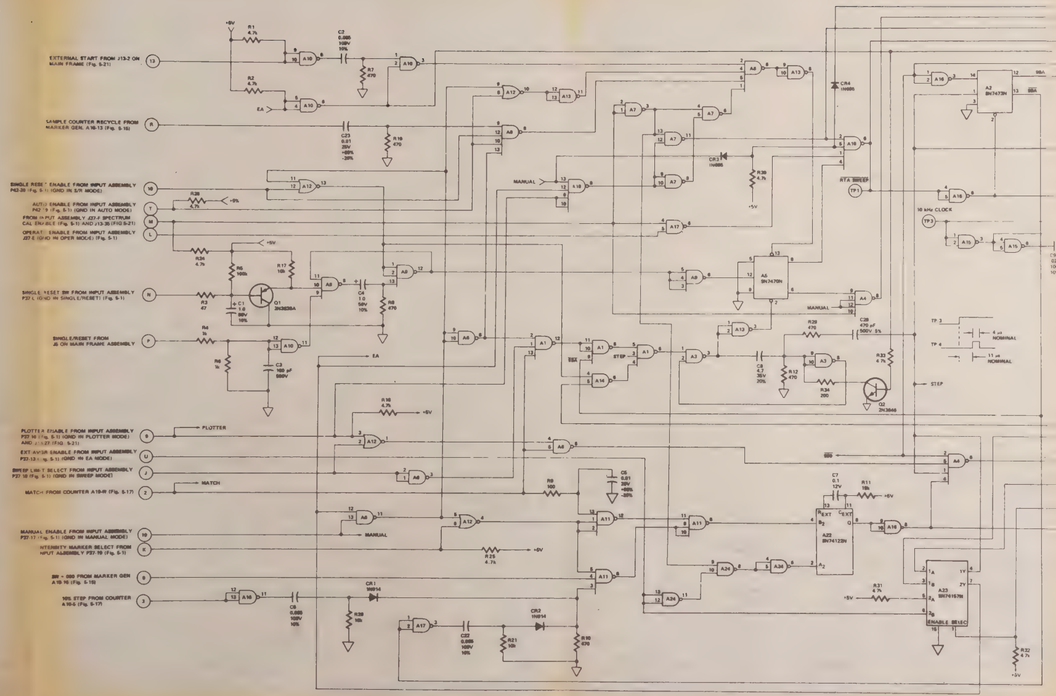
2 INTEGRATED CIRCUIT TYPES

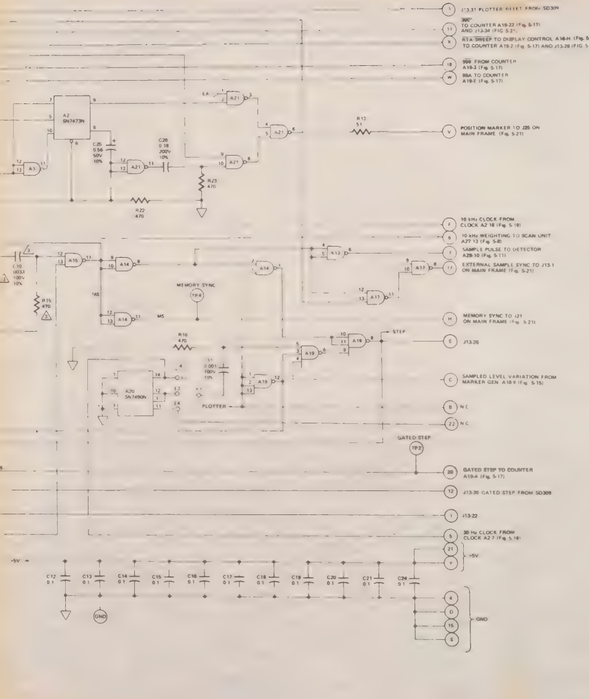
REF DESIG	TYPE	GND	+5V
A1	SN7491J	PIN 10	PIN 5
A2	SN7474N	PIN 7	PIN 14
A3	SN7486N	PIN 7	PIN 14
A4	SN7430N	PIN 7	PIN 14
A5	SN7410N	PIN 7	PIN 14
A6	SN7400N	PIN 7	PIN 14
A7	SN7402N	PIN 7	PIN 14
A8	SN7408N	PIN 7	PIN 14
A9	SN7490N	PIN 10	PIN 5
A10	SN7475N	PIN 7	PIN 14
A11	SN7400N	PIN 7	PIN 14
A12	SN7430N	PIN 7	PIN 14
A13	SN7408N	PIN 7	PIN 14
A14	SN7410N	PIN 7	PIN 14
A15	SN7400N	PIN 7	PIN 14
A16	SN7490N	PIN 10	PIN 5

4 UNUSED INTEGRATED CIRCUITS

MARKER GENERATOR
(Assembly 12520-1, Ckt Card A18)
Figure 5-15.




EXTERNAL START FROM J13-2 ON MAIN FRAME (Fig. 5-21)
SAMPLE COUNTER RECYCLE FROM MARKER GEN. A16-13 (Fig. 5-16)
SINGLE RESET ENABLE FROM INPUT ASSEMBLY P42-39 (Fig. 5-1) (GND IN S/R MODE)
AUTO ENABLE FROM INPUT ASSEMBLY P42-9 (Fig. 5-1) (GND IN AUTO MODE)
FROM H-PUT ASSEMBLY J27-F SPECTRUM CAL ENABLE (Fig. 5-1) AND J13-3E (FIG 5-21)
OPERATE ENABLE FROM INPUT ASSEMBLY J27-E (GND IN OPER MODE) (Fig. 5-1)
SINGLE RESET SW FROM INPUT ASSEMBLY P37-L (GND IN SINGLE/RESET) (Fig. 5-1)
SINGLE/RESET FROM J5 ON MAIN FRAME ASSEMBLY
PLOTTER ENABLE FROM INPUT ASSEMBLY P37-W (Fig. 5-1) (GND IN PLOTTER MODE) AND J13-2T (FIG. 5-21)
EXT MAYOR ENABLE FROM INPUT ASSEMBLY P37-13 (Fig. 5-1) (GND IN EA MODE)
BWSP LIM T SELECT FROM INPUT ASSEMBLY P37-18 (Fig. 5-1) (GND IN SWEEP MODE)
MATCH FROM COUNTER A19-W (Fig. 5-17)
MANUAL ENABLE FROM INPUT ASSEMBLY P37-17 (Fig. 5-1) (GND IN MANUAL MODE)
INTENSITY MARKER SELECT FROM INPUT ASSEMBLY P37-19 (Fig. 5-1)
2M - 20M FROM MARKER GEN A 16-16 (Fig. 5-16)
10% STEP FROM COUNTER A 19-E (Fig. 5-17)
PLOTTER
MATCH
MANUAL
EA
STEP
ATA SWEEP
10 kHz CLOCK
MEMORY SYNC
GATED STEP
ENABLE SELECT
+5V
+10V
-5V
GND


J13-3T PLOTTER ASSIST FROM J-SD309
TO COUNTER A19-22 (Fig. 5-17)
ATA SWEEP TO DISPLAY CONTROL A16H (Fig. 5-21)
TO COUNTER A19-J (Fig. 5-17) AND J13-2R (FIG. 5-21)
FROM COUNTER A19-Z (Fig. 5-17)
TO COUNTER A19-F (Fig. 5-17)
POSITION MARKER TO J2S ON MAIN FRAME (Fig. 5-21)
10 kHz CLOCK FROM CLOCK A2 1B (Fig. 5-19)
10 kHz WEIGHTING TO SCAN UNIT A27 13 (Fig. 5-8)
SAMPLE PULSE TO DETECTOR A28-1B (Fig. 5-11)
EXTERNAL SAMPLE SYNC TO J13-1 ON MAIN FRAME (Fig. 5-21)
MEMORY SYNC TO J21 ON MAIN FRAME (Fig. 5-21)
J13-2R
SAMPLED LEVEL VARIATION FROM MARKER GEN. A16-H (Fig. 5-16)
N.C.
N.C.
GATED STEP TO COUNTER A19-A (Fig. 5-17)
J13-3S GATED STEP FROM SD-309
J13-2Z
10 kHz CLOCK FROM CLOCK A27 (Fig. 5-19)
-5V
GND

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NOTES:

1. UNLESS OTHERWISE INDICATED RESISTOR VALUES ARE IN OHMS 1/4W 5% AND CAPACITOR VALUES IN MICRO FARADS 12V 20%
2. INTEGRATED CIRCUIT TYPES

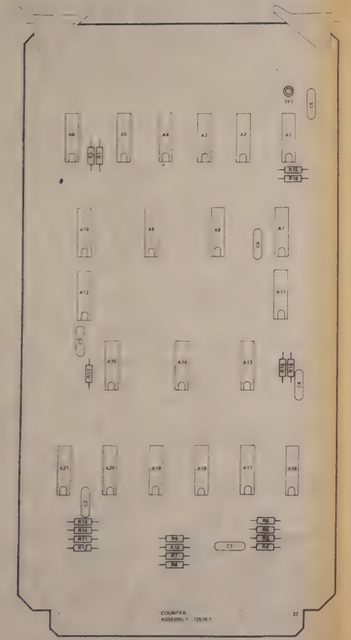
REF DESIG	TYPE	+5V	GND
A1	SN74 10N	PIN 14	PIN 7
A2	SN74173N	PIN 14	PIN 7
A3	CM4000BN	PIN 14	PIN 7
A4	CM4000BN	PIN 14	PIN 7
A5	SN74175N	PIN 14	PIN 7
A6	CM4000BN	PIN 14	PIN 7
A7	CM4000BN	PIN 14	PIN 7
A8	SN74128N	PIN 14	PIN 7
A9	SN74121N	PIN 14	PIN 7
A10	CM4002BN	PIN 14	PIN 7
A11	SN74 10N	PIN 14	PIN 7
A12	SN74S02N	PIN 14	PIN 7
A13	CM4000BN	PIN 14	PIN 7
A14	CM4000BN	PIN 14	PIN 7
A15	CM4000BN	PIN 14	PIN 7
A16	CM4000BN	PIN 14	PIN 7
A17	CM4000BN	PIN 14	PIN 7
A18	SN74128N	PIN 14	PIN 7
A19	SN74 10N	PIN 14	PIN 7
A20	SN74S00N	PIN 5	PIN 10
A21	SN74S00N	PIN 14	PIN 7
A22	SN74123N	PIN 14	PIN 7
A23	SN74S37N	PIN 16	PIN 8
A24	SN74S02N	PIN 14	PIN 7

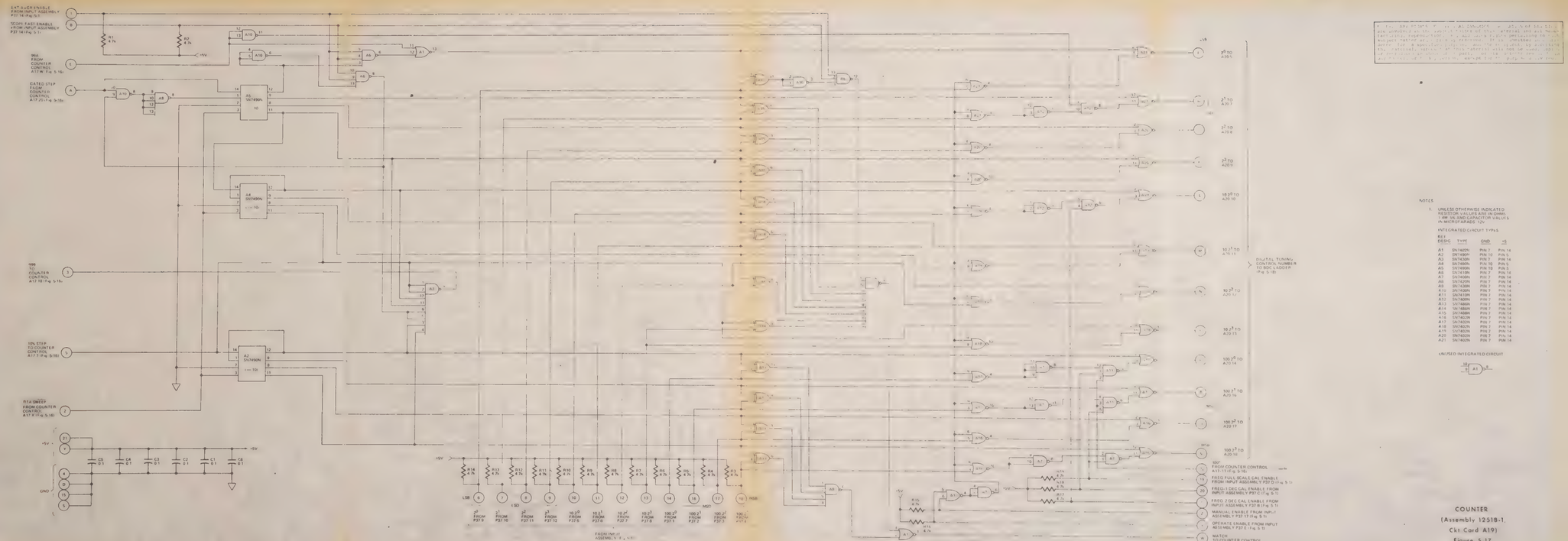
⚠ FACTORY SELECTED WITH TYPICAL VALUE SHOWN

⚠ JUMPER FROM E1 TO E3 INSTALLED AT FACTORY

JUMPER	FREQUENCY	SWEEP TIME
E1-E2	20 Hz	32 sec
E1-E3	55 Hz	64 sec
E1-E4	3 Hz	320 sec

COUNTER CONTROL
(Assembly 10080100
Ckt Card A17)
Figure 5-16.




EXT + OR ENABLE FROM INPUT ASSEMBLY P37-14 (Fig. 5-11)
SCOPE FAST ENABLE FROM INPUT ASSEMBLY P37-14 (Fig. 5-11)
+5V
1MS FROM COUNTER CONTROL A17-W (Fig. 5-16)
GATED STEP FROM COUNTER CONTROL A17-20 (Fig. 5-16)
1MS TO COUNTER CONTROL A17-18 (Fig. 5-16)
10% STEP TO COUNTER CONTROL A17-17 (Fig. 5-16)
RT-A-DWELL FROM COUNTER CONTROL A17-X (Fig. 5-16)
GND
FROM INPUT ASSEMBLY P37-6
DIGITAL TUNING CONTROL NUMBER TO BDC LOGISTIC (Fig. 5-18)
100V FROM COUNTER CONTROL A17-17 (Fig. 5-16)
FREQ FULL SCALE CAL ENABLE FROM INPUT ASSEMBLY P37-D (Fig. 5-11)
FREQ-1 DEC CAL ENABLE FROM INPUT ASSEMBLY P37-C (Fig. 5-11)
FREQ-2 DEC CAL ENABLE FROM INPUT ASSEMBLY P37-B (Fig. 5-11)
MANUAL ENABLE FROM INPUT ASSEMBLY P37-17 (Fig. 5-11)
OPERATE ENABLE FROM INPUT ASSEMBLY P37-5 (Fig. 5-11)
WATCH TO COUNTER CONTROL A17-7 (Fig. 5-16)

NOTES

1. UNLESS OTHERWISE INDICATED:
   RESISTOR VALUES ARE OHMS
   1.4W 5% SINGLE CAPACITOR VALUES IN MICROFARADS 12V

INTEGRATED CIRCUIT TYPES

REF DESIG	TYPE	GND	+5
A1	SN7402N	PIN 7	PIN 14
A2	SN7490N	PIN 10	PIN 5
A3	SN7430N	PIN 7	PIN 14
A4	SN7490N	PIN 10	PIN 5
A5	SN7490N	PIN 10	PIN 5
A6	SN7430N	PIN 7	PIN 14
A7	SN7450N	PIN 7	PIN 14
A8	SN7420N	PIN 7	PIN 14
A9	SN7430N	PIN 7	PIN 14
A10	SN7430N	PIN 7	PIN 14
A11	SN7410N	PIN 7	PIN 14
A12	SN7420N	PIN 7	PIN 14
A13	SN7480N	PIN 7	PIN 14
A14	SN7480N	PIN 7	PIN 14
A15	SN7408N	PIN 7	PIN 14
A16	SN7402N	PIN 7	PIN 14
A17	SN7402N	PIN 7	PIN 14
A18	SN7402N	PIN 7	PIN 14
A19	SN7402N	PIN 7	PIN 14
A20	SN7402N	PIN 7	PIN 14
A21	SN7402N	PIN 7	PIN 14

UNUSED INTEGRATED CIRCUIT

COUNTER
(Assembly 12518-1, Ckt Card A19)
Figure 5-17

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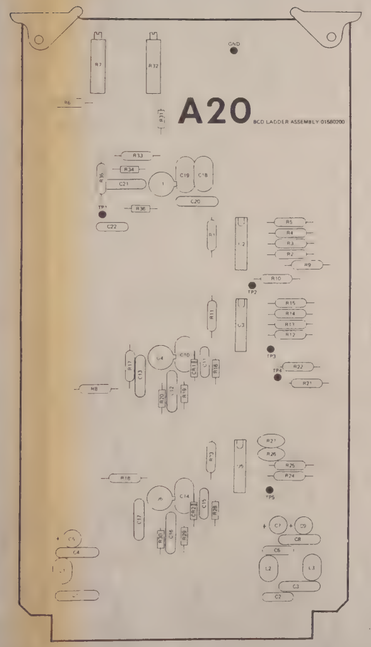
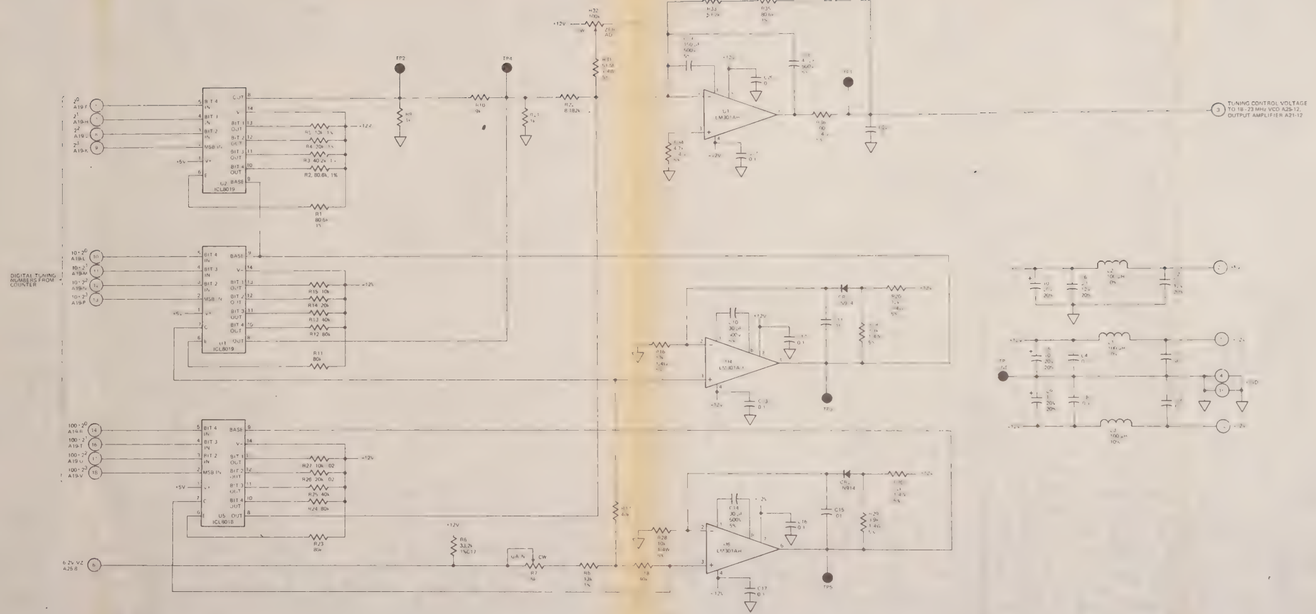


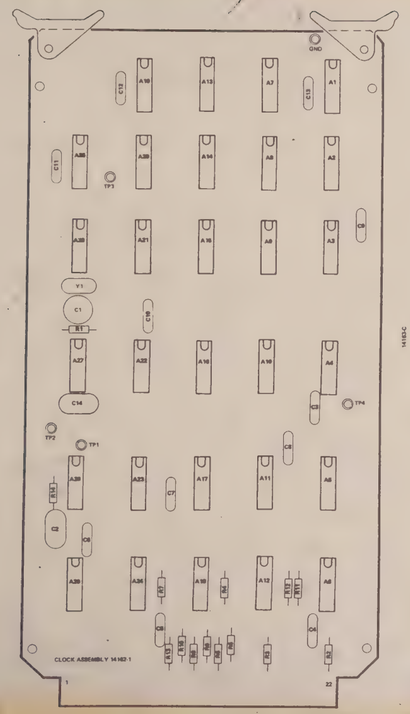


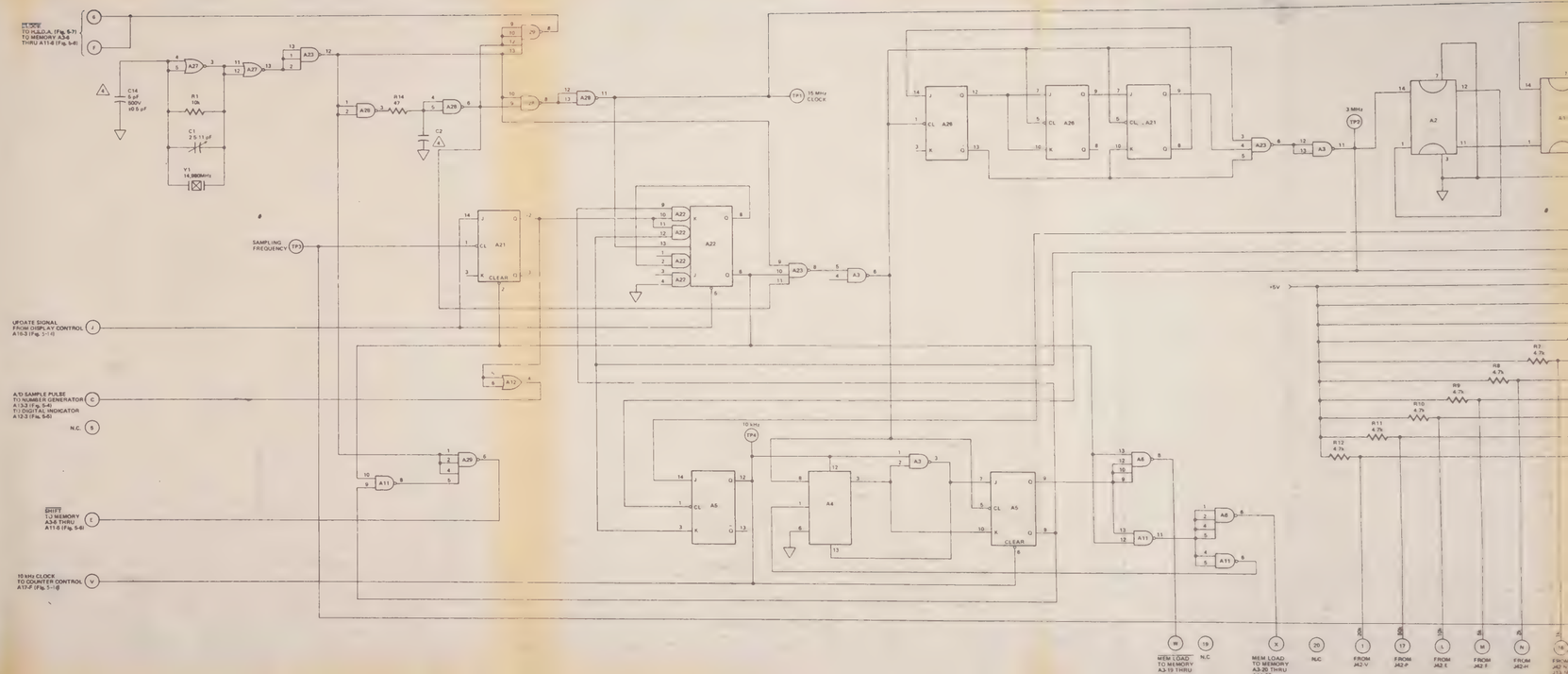
NOTES UNLESS OTHERWISE INDICATED:

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/8W, ±0.1%
   (c) CAPACITANCE SHOWN IN MICROFARADS
   (d) CAPACITORS 25V, +80 -20%

HIGHEST REF. DESIG. USED
C2
CR2
L1
R36
TP5
U5

BCD LADDER
(ASSEMBLY 01580200
CKT CARD A20)
FIGURE 5-18


GND
TP3
TP2
TP1
TP4
V1
C1
R1
C14
CLOCK ASSEMBLY 14 H52-1
1
22


TO H.A.D.A. (Fig. 5-7)
TO MEMORY A3-6
THRU A11-6 (Fig. 5-6)
C14
6 pF
500V
±0.5 pF
R1
10k
C1
2.5-11 pF
V1
14.380MHz
R14
47
C2
15 MHz
CLOCK
SAMPLING
FREQUENCY
TP3
UPDATE SIGNAL
FROM DISPLAY CONTROL
A16-3 (Fig. 5-11)
A/D SAMPLE PULSE
TO NUMBER GENERATOR
A1-3 (Fig. 5-4)
TO OVERLOAD INDICATOR
A12-3 (Fig. 5-6)
N.C.
SHIFT
TO MEMORY
A3-6 THRU
A11-6 (Fig. 5-6)
10 kHz CLOCK
TO COUNTER CONTROL
A17-F (Fig. 5-18)
10 kHz
TP4
3 MHz
TP5
+5V
R3
4.7k
R8
4.7k
R9
4.7k
R10
4.7k
R11
4.7k
R12
4.7k
MEM LOAD
TO MEMORY
A3-19 THRU
A11-19
N.C.
MEM LOAD
TO MEMORY
A3-20 THRU
A11-20
N.C.
FROM
A42-V
FROM
A42-P
FROM
A42-E
FROM
A42-F
FROM
A42-H
FROM
A42-N
FROM
A42-S

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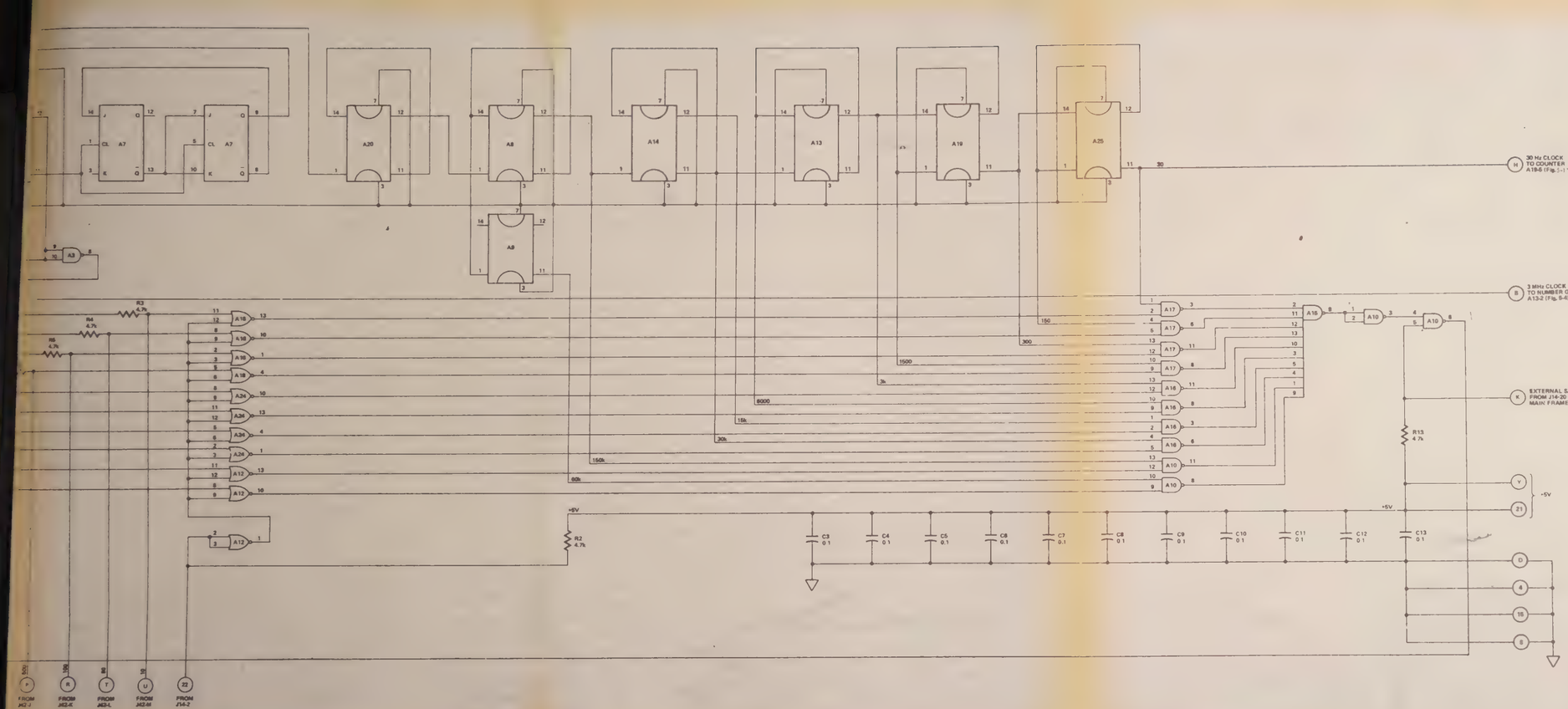


NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS 1/4W, 5%
   ALL CAPACITOR VALUES ARE IN MICROFARADS
   0.1 ARE 12V, 20%

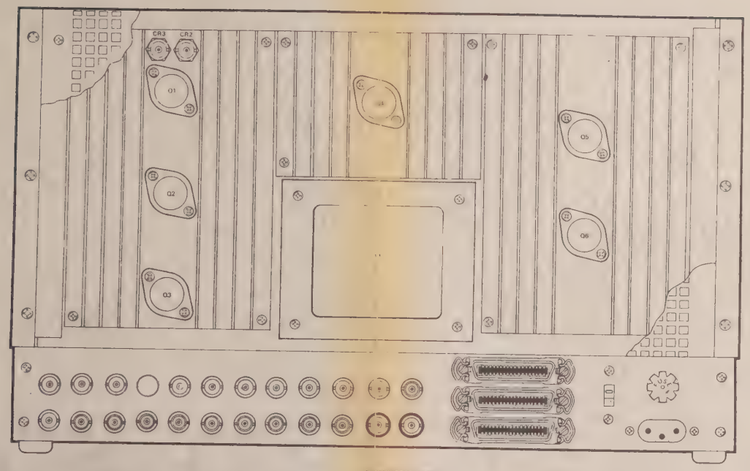
2. INTEGRATED CIRCUIT TYPES:

REF DESIG	TYPE	GND	+5V
A1	SN7490N	PIN 10	PIN 5
A2	SN7489N	PIN 10	PIN 5
A3	8N74H00N	PIN 7	PIN 14
A4	MB2844A	PIN 7	PIN 14
A5	SN74H73N	PIN 11	PIN 4
A6	SN74H40N	PIN 7	PIN 14
A7	SN7473N	PIN 11	PIN 4
A8	SN7490N	PIN 10	PIN 5
A9	SN7490N	PIN 10	PIN 5
A10	SN7400N	PIN 7	PIN 14
A11	SN74H00N	PIN 7	PIN 14
A12	SN7402N	PIN 7	PIN 14
A13	SN7490N	PIN 10	PIN 5
A14	SN7490N	PIN 10	PIN 5
A15	MC1809P	PIN 7	PIN 14
A16	SN7400N	PIN 7	PIN 14
A17	SN7400N	PIN 7	PIN 14
A18	SN7402N	PIN 7	PIN 14
A19	SN7490N	PIN 10	PIN 5
A20	SN7490N	PIN 10	PIN 5
A21	SN74H73N	PIN 11	PIN 4
A22	SN74H71N	PIN 7	PIN 14
A23	SN74H10N	PIN 7	PIN 14
A24	SN7402N	PIN 7	PIN 14
A25	SN7490N	PIN 10	PIN 5
A26	SN74H73N	PIN 11	PIN 4
A27	SP380A	PIN 1	PIN 8
A28	SN74H00N	PIN 7	PIN 14
A29	SN74H40N	PIN 7	PIN 14

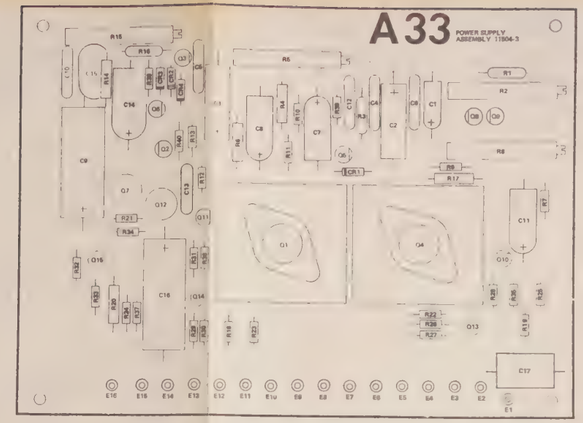
3 UNUSED PORTIONS OF INTEGRATED CIRCUITS.

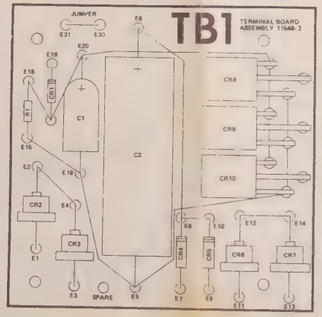
4 VALUE FACTORY SELECTED.

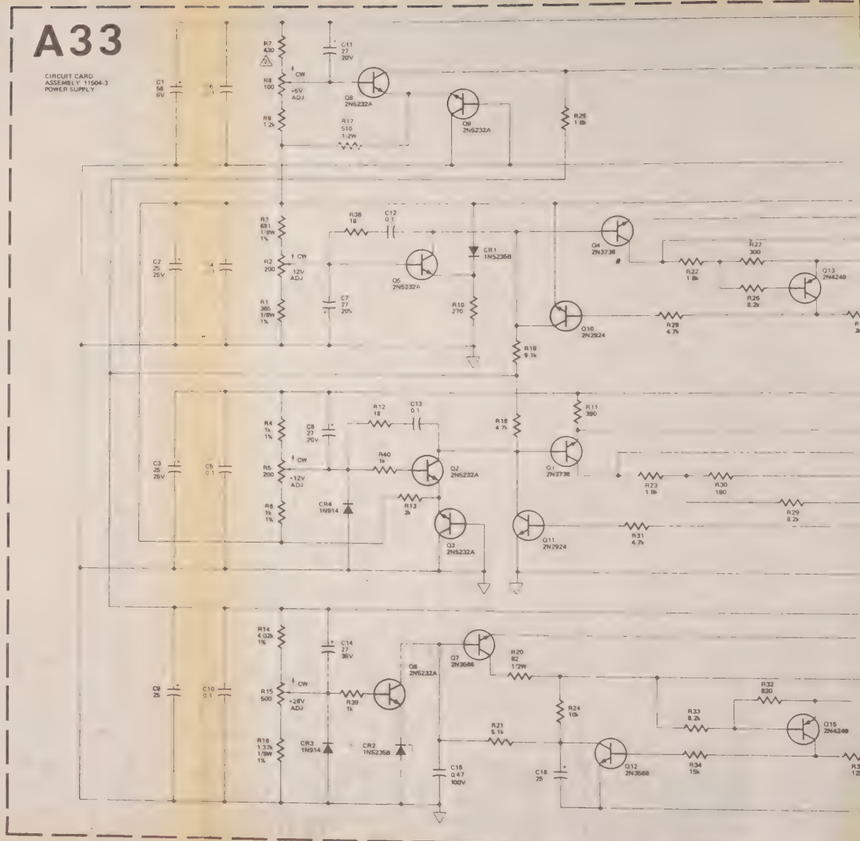
CLOCK
(Assembly 14162-1, Ckt Card A2)
Figure 6-18.



CHASSIS REAR VIEW
(HEAT SINK COMPONENTS)







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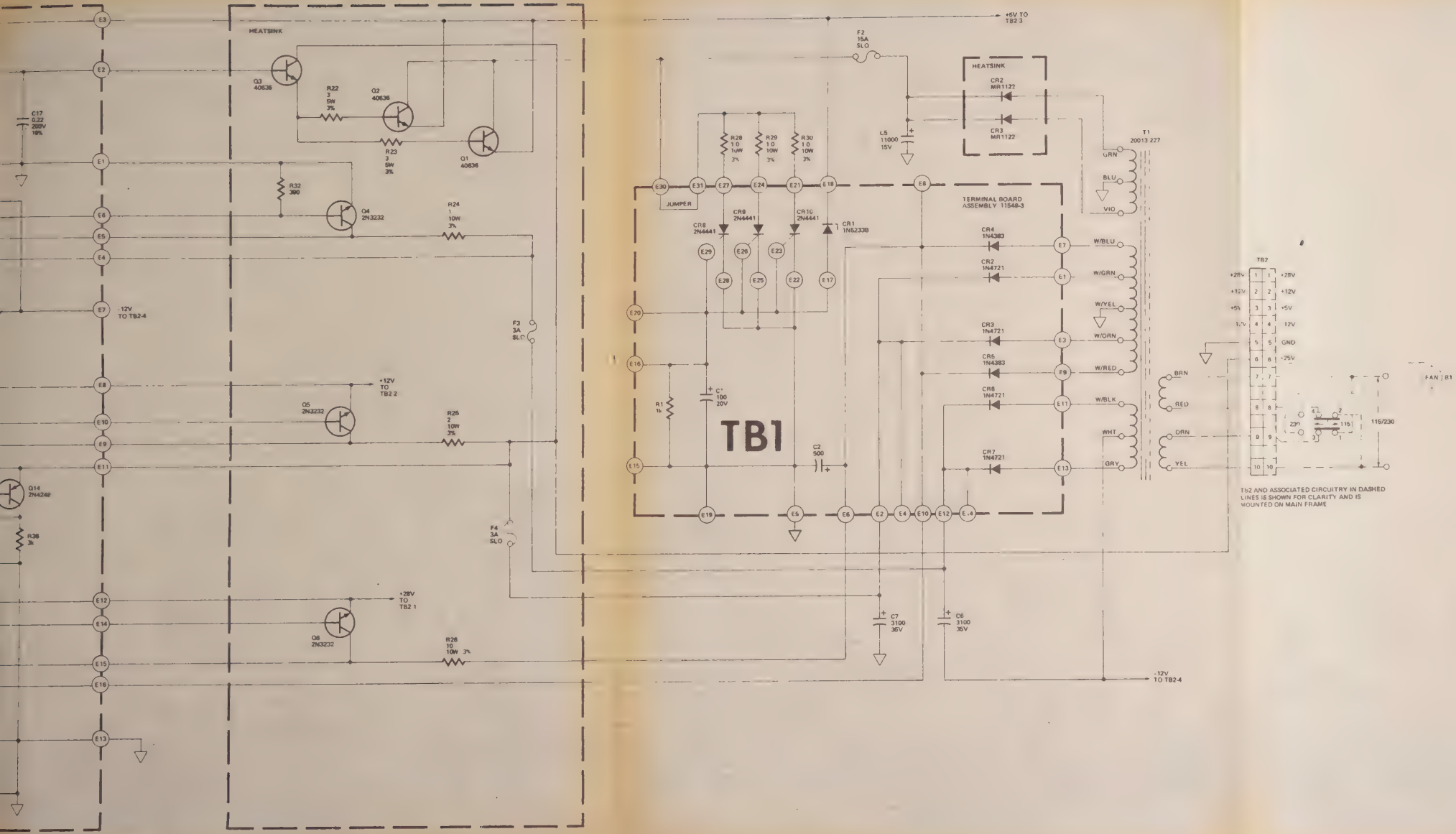
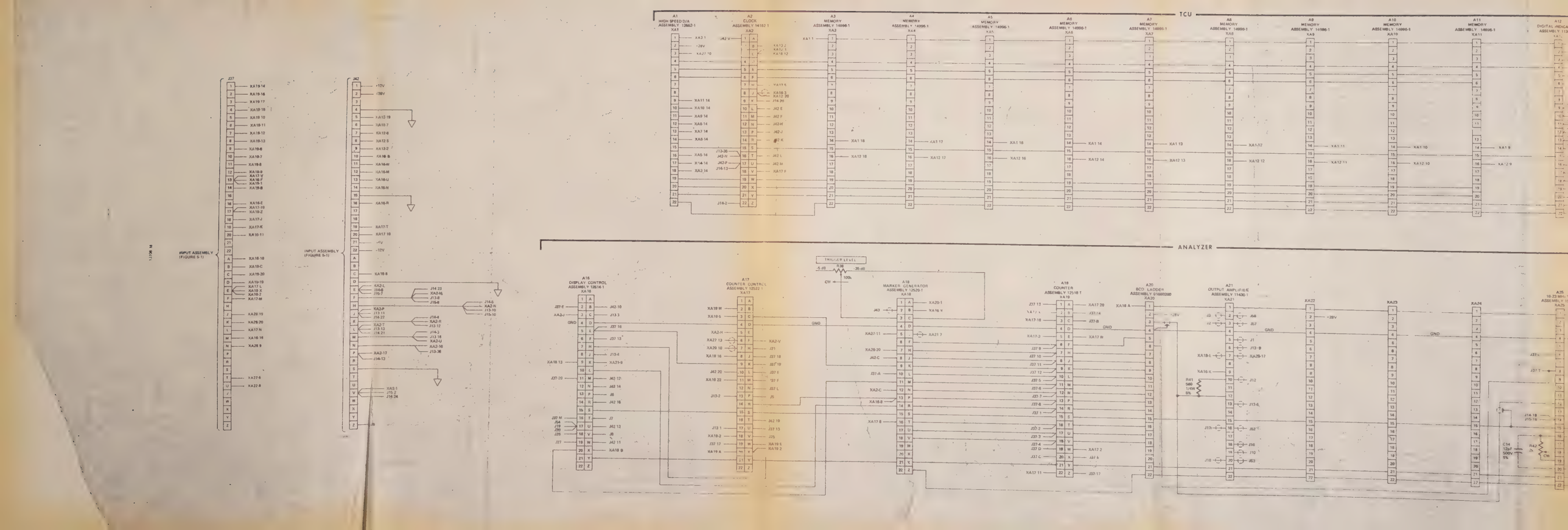


NOTES UNLESS OTHERWISE INDICATED

1 RESISTOR VALUES ARE IN OHMS, 1/4W, 5% AND CAPACITOR VALUES IN MICROFARADS, 50V +80% -20%

⚠ FACTORY SELECT WITH OPTIMUM VALUE SHOWN.

POWER SUPPLY
(Assembly 13980-1)
Figure 5-20.


TCU
ANALYZER
INPUT ASSEMBLY (FIGURE 5-1)
INPUT ASSEMBLY (FIGURE 5-1)
A1 HIGH SPEED D/A ASSEMBLY 12662-1
A2 CLOCK ASSEMBLY 14162-1
A3 MEMORY ASSEMBLY 14996-1
A4 MEMORY ASSEMBLY 14996-1
A5 MEMORY ASSEMBLY 14996-1
A6 MEMORY ASSEMBLY 14996-1
A7 MEMORY ASSEMBLY 14996-1
A8 MEMORY ASSEMBLY 14996-1
A9 MEMORY ASSEMBLY 14996-1
A10 MEMORY ASSEMBLY 14996-1
A11 MEMORY ASSEMBLY 14996-1
A12 DIGITAL INTERFACE ASSEMBLY 11139
A16 DISPLAY CONTROL ASSEMBLY 12616-1
A17 COUNTER CONTROL ASSEMBLY 12522-1
A18 MARKER GENERATOR ASSEMBLY 12520-1
A19 COUNTER ASSEMBLY 12518-1
A20 BCD LADDER ASSEMBLY 01980200
A21 OUTPUT AMPLIFIER ASSEMBLY 11430-1
TRIGGER LEVEL
+28V
GND
CW
100k
5 dB
35 dB
R41 560 1/4W 5%
C14 12pF 500V 5%

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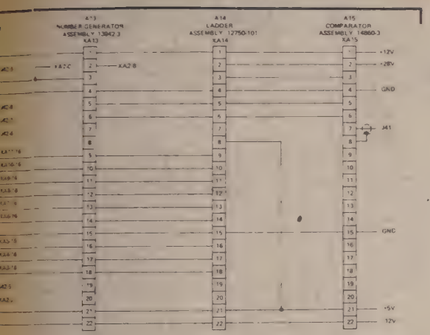
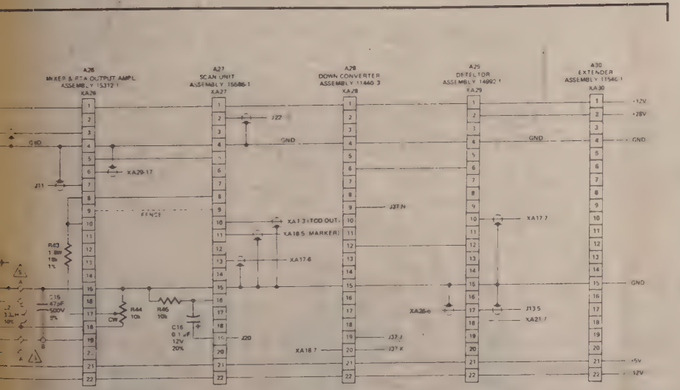
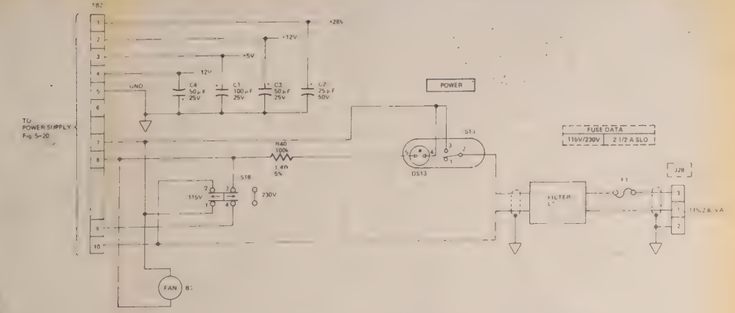
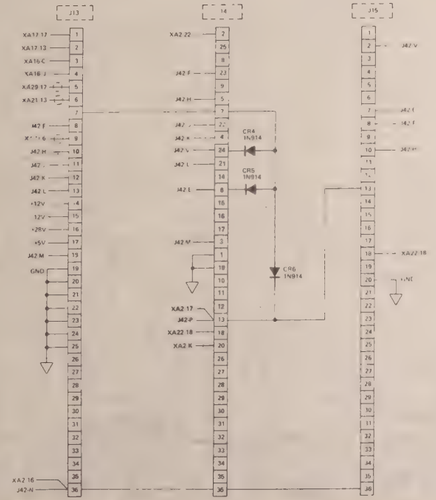
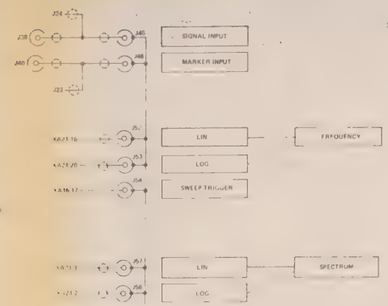
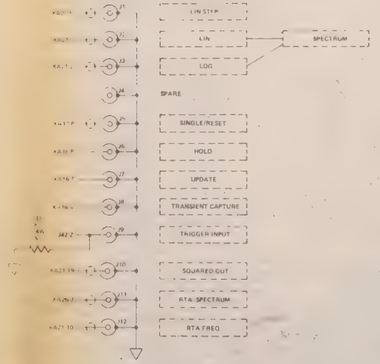


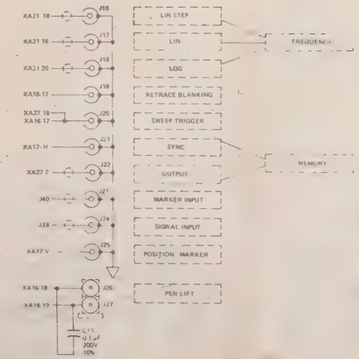












NOTES:

1. SYMBOL ▭ INDICATES FRONT PANEL LOCATION
2. SYMBOL ▭ INDICATES REAR CHASSIS LOCATION
3. ALL COAX GROUNDED AT BOTH ENDS

A. FACTORY ADJUST WITH OPTIMUM VALUE SHOWN PHYSCIAL POSITION CRITICAL

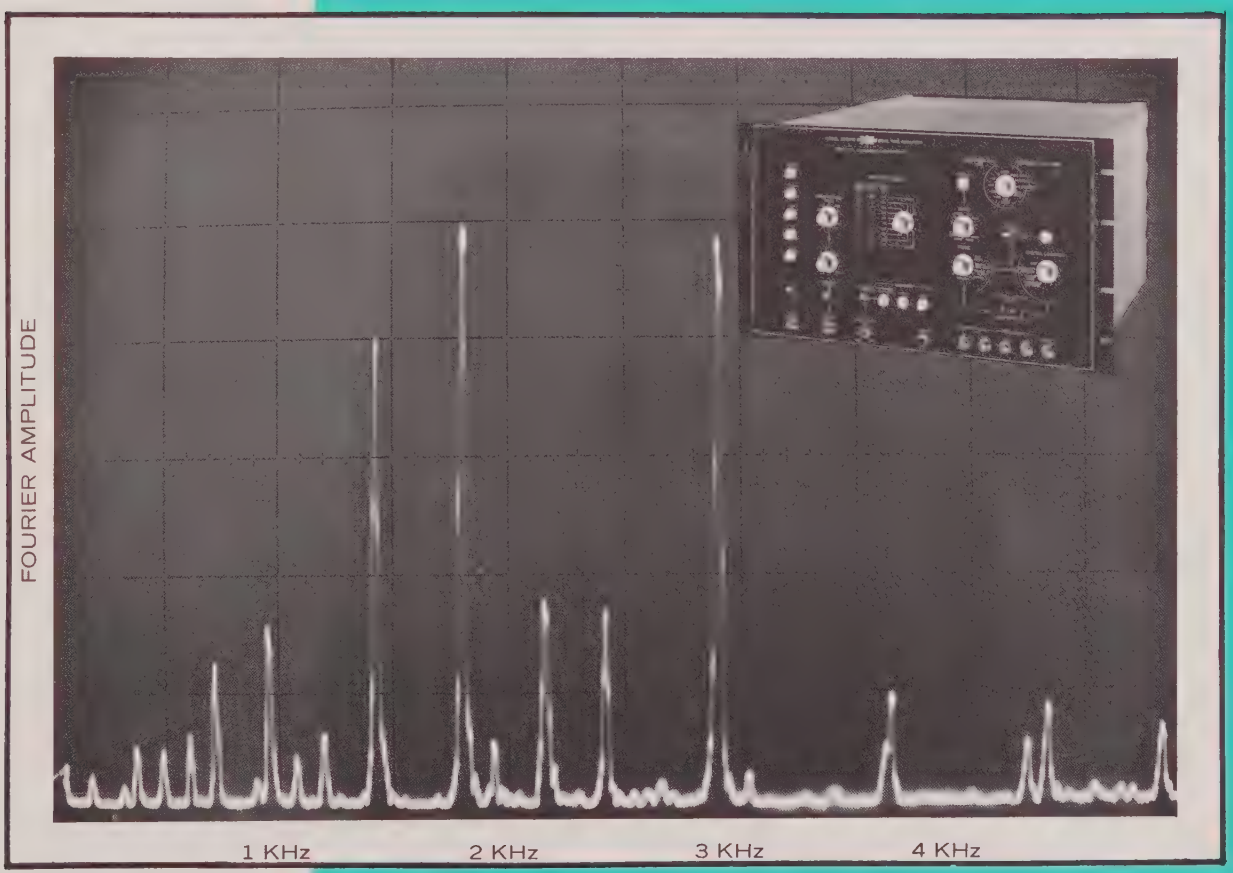
B. CONNECTION TO POINT A OR B DETERMINED DURING FACTORY CALIBRATION

MAIN FRAME
(Assembly 13710-1)
Figure 5-21

SD301C REAL TIME ANALYZER

on-line SPECTRUM ANALYSIS

- TRANSIENT ANALYSIS
- VIBRATION (GROUND TEST OR FLIGHT DATA)
- ACOUSTIC ANALYSIS
- SPECTRUM "SIGNATURE" DETERMINATION
- SPEECH ANALYSIS
- TURBINE & MACHINERY SIGNATURE RATIO® ANALYSIS
- SHOCK STUDIES
- PSD ANALYSIS
- ON-LINE RANDOM VIBRATION EQUALIZATION VERIFICATION
- OCEAN WAVE ANALYSIS
- AIRCRAFT FLYOVER ANALYSIS
- 3-D DISPLAY OF TIME VARYING SPECTRA



SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO
POST OFFICE BOX 671, SAN DIEGO, CALIFORNIA 92112
TELEPHONE 714—278-2501 • TWX 910-335-2022

FEATURES

- 10 analysis ranges; 10 Hz to 50 kHz full scale
- 1 dB stepped input attenuator—insures accurate range settings from 100 mV rms to 28.2 V rms
- 0, 10, 20 or 26 dB post filter gain—selectable for optimized signal averaging tasks.
- 500 "Line" analysis provides resolution to 0.03 Hz
- Transient capture with control over location of data in memory provides accurate transient signal analysis automatically
- Linear and Log outputs for both spectrum amplitude and frequency
- Simple "one control" calibration—quick and repeatable
- Unique intensity marker allows quick and precise identification of frequency components
- Three plotter readout rates with Sweep Rate Feedback to allow fastest readout rate without exceeding slewing rates of X-Y recorder
- Ready to grow with your requirements thanks to a broad range of accessories
- Simplified computer interface—remote programming and digital output (see SD301C-C and SD301C-12 on P. 4)
- Remote control of logic and readout functions
- Unique, absolute, frequency calibration across entire spectrum—one step

NEW• Ultra fast (≈5 second) warmup—ready when you are.

INTRODUCTION

• What is "real time" spectrum analysis?

It's a means of determining the spectral content of a complex signal at a rate commensurate with on-line processing. The SD301C Real Time Analyzer performs an analysis of the input signal and displays the Fourier magnitude vs. frequency once every 50 milliseconds, or 20 Fourier analyses per second. The minimum length of time (T) over which a signal must be analyzed to derive its spectral content is a function of the reciprocal of the analysis bandwidth (B). For optimized analysis, the product BT should be a constant and, ideally, BT=1.

• How quickly can a spectrum analysis be performed?

The rate at which a filter can be swept through the frequency range of analysis is dependent on the width and shape of the filter used. For a single pole filter "B" Hz wide, this rate is B^2Hz/second. For more selective filters, a slower rate would be necessary. The SD301C Real Time Analyzer utilizes a single pole filter and a time weighting function in order to achieve minimum data processing time and optimum filter characteristics.

• How can "real time" analysis be achieved?

Several techniques have been employed to decrease the time required to perform a spectrum analysis. These include automatically increasing the filter bandwidth as the analysis frequency increases and data frequency speedup using magnetic tape. Increasing filter bandwidth is usually not very helpful when analyzing periodic data associated with rotating machinery or periodic signals masked by random data.

A digital time compression technique is employed in the SD301C Real Time Analyzer for the signal speedup. This provides speedup ratios which vary from 100 to 500,000 depending on the analysis range selected. As a result, the SD301C is capable of performing a complete spectrum analysis in a fraction of a second.

• What is meant by "500 line" analyzer?

The number of resolution elements or synthesized filter locations in a Real Time Analyzer has been termed "lines." There are 500 synthesized filter locations in the SD301C. The filter locations are equally spaced across the range of analysis and determine the "resolution" shown in Table I. In actuality, a single filter is used. The data is passed through the filter by heterodyning it 500 times in fixed steps, each step equal to the bandwidth of the filter, using a stepped oscillator.

The cyclic rate of the memory in the SD301C Real Time Analyzer is 100 microseconds. The time required to perform a complete spectrum analysis is the time required to step the data through the 500 "locations" or 500×100 microseconds=50 milliseconds. If loading of the analyzer memory is equal to or longer than the analysis time (50 ms), the analysis can be considered to be on line or "real time," and 100% of the incoming signal is analyzed. A "500 line" analyzer with a 100 microsecond memory is "real time" to 10 kHz.

• What is meant by Effective Filter Bandwidth?

For the real time process to produce satisfactory results, the condition BT=1 must be satisfied. In the SD301C, this is achieved by using a filter with a 10 kHz bandwidth since we are using a memory period of 100 microseconds. The effective bandwidth of the analysis process is inversely proportional to the amount the data has been "sped up." For example, in the 10kHz analysis range, the data is sped up by a factor of 500 to one. Thus, the effective bandwidth of the data is 1/500×10 kHz=20 Hz. Time weighting, which is used to compensate for truncation errors associated with the finite memory used to time compress the signals, has the effect of increasing the 3dB points of the filter by 50% so the bandwidth in the example becomes 30 Hz.

CONCEPTS OF SIMPLIFIED BLOCK DIAGRAM

Data that is applied to the SD301C Real Time Analyzer (Fig. 1) enters through a buffer amplifier to a lowpass, anti-aliasing filter. Signals at twice the upper frequency limit are attenuated by at least 54 dB at this point. The signal is then digitized at a rate 3 times the upper frequency and applied, through another buffer, to a recirculating memory. The memory has capacity for 1500 nine-bit parallel words. Signal speedup results from the fact that the data is always loaded at the digitizing rate which is always a multiple of 100 microseconds, but always unloads from the memory in the fixed time of 100 microseconds. Returning to our example, on the 10 kHz range, it takes 50 milliseconds to load and 100 microseconds to unload, which produces a speedup of 500.

Data is converted back to analog form as ot exits from the memory. The signal is then heterodyned to the center frequency of the analyzer filter, weighting is added and filtering is accomplished. (This process is repeated 500 times for a complete analysis.) The detector output is then representative of the amplitude vs. filter location of the input signal. This signal is then applied to both linear and log amplifiers for display on an oscilloscope, X-Y plotter or other data processing device. The means is also available to store data in the recirculating memory via a HOLD mode of operation making it possible to capture and analyze transient phenomena.

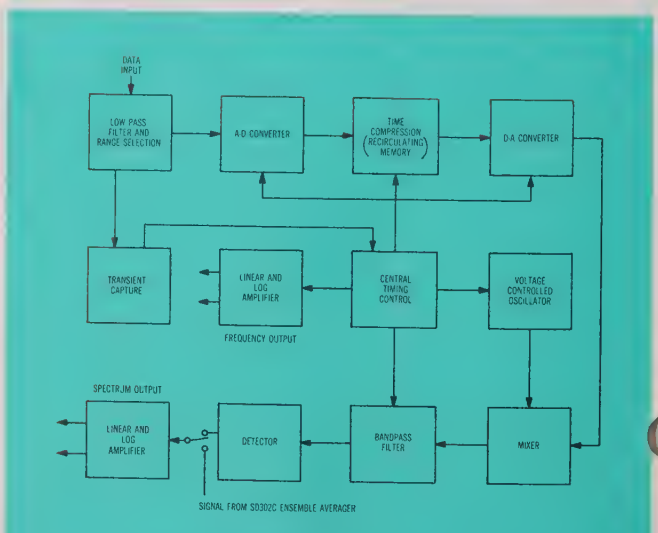
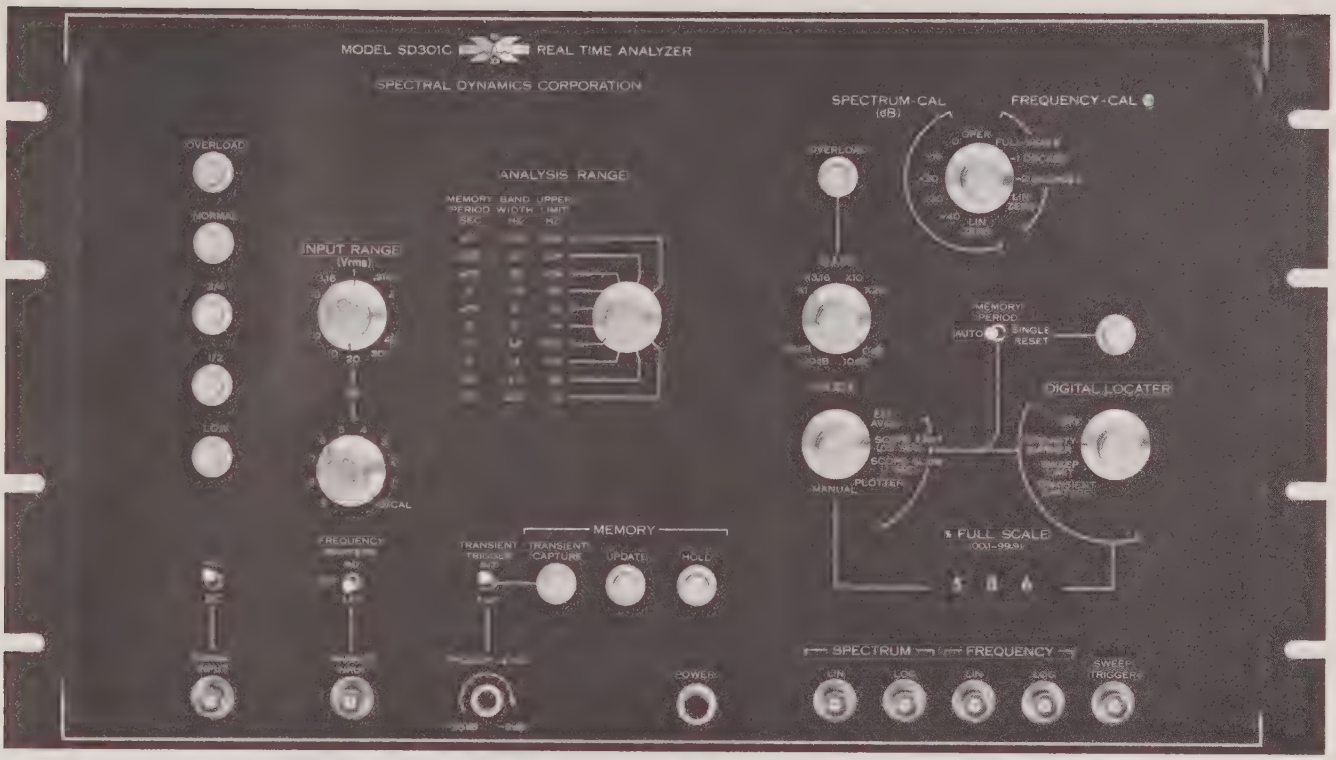


FIG. 1. SD301C SIMPLIFIED BLOCK DIAGRAM



1. Input

Selects AC/DC input coupling and voltage range adjustable in 1 dB and 10 dB steps. Provides input level indication directly from digitized data giving correct signal amplitude regardless of wave shape; for example, periodic, random or transient signals. Either internal or external frequency markers may be added to the display. These markers are added behind the analyzer memory so that they may be introduced or removed at any time.

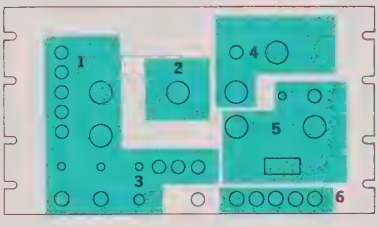


FIG. 2. SD301C FRONT PANEL CONTROLS

2. Frequency range selection

10 full scale ranges—10 Hz to 50 kHz. Selects input low pass (anti-aliasing) filter, data sampling rate and analyzer filter bandwidth for each range. External sampling input furnished on rear connector.

3. Memory Control/Transient Capture

Push-button controls select memory UPDATE for continuous sampling of new input data, memory HOLD with the latest memory period of data held in memory and new data inhibited, or TRANSIENT CAPTURE where the analyzer is "armed" and prepared to load the selected number of words in memory. Triggering in the Transient Capture mode is accomplished by an external pulse or by the incoming signal if it exceeds an adjustable threshold level. This level can be preset between 5 dB and 35 dB below the selected input full scale.

4. Calibration/Output Gain

SPECTRUM CAL positions are used in conjunction with the input range 1 dB step attenuator to provide absolute voltage cal levels or cal levels relative to an external signal. Full scale and zero for linear display or fixed 1 dB and 10 dB steps for log display.

FREQUENCY CAL provides d-c voltage proportional to analyzer frequency for rapid readout device calibration using either linear or log displays. Tunes the analyzer to the selected point for rapid "absolute" check.

OUTPUT GAIN—Selects post filter gain prior to display or averaging. Especially useful for random signal and transient analysis; affects memory contents and markers. (Note—internal markers are attenuated in upper gain positions to prevent overload.)

5. Output Mode Controls/ Digital Locater

Select the operational mode and analyzer output rate to be one of the following:

EXTERNAL AVERAGER: Timing controls are furnished by an external averager; for example, the SD302C Ensemble Averager.

SCOPE FAST: Provides a readout rate of one complete spectrum scan every 50 milliseconds in the AUTO mode.

SCOPE SLOW: Provides a readout rate of one complete spectrum sweep every 100 milliseconds in the AUTO mode.

MEMORY PERIOD: A complete spectrum is presented at the selected readout rate once each time memory is updated with new data. (Non-redundant outputs.)

SINGLE/RESET: Provides a single spectrum display each time the push button is depressed or an external trigger signal applied.

PLOTTER: An output spectrum sweep is provided in 32, 64 or 320 seconds (as determined by an internal jumper) and as affected by "sweep rate feedback."

MANUAL: Operates as a tuned filter with the center frequency manually selected by the three-digit thumbwheel selector, % full scale.

DIGITAL LOCATER:

Intensity Marker: Provides intensified markers (one adjustable, or ten equally spaced) for precise location of frequency points during oscilloscope display modes.

Sweep Limit: Limits output display sweep to a selected frequency in Scope and Plotter modes.

Transient Capture: Determines the number of data points to be loaded into memory in the Transient Capture Memory mode as a direct reading of the percent of full scale switch.

6. Outputs

Frequency and spectrum outputs are furnished in both linear and log forms (squared output optional) and a sweep trigger is furnished for use with oscilloscopes not having X-Y drive capability.

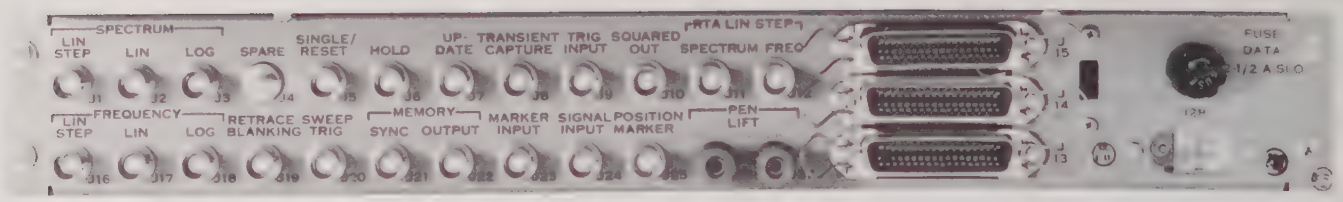


FIG. 3. SD301C REAR CONNECTOR PANEL

J13 — 36-pin connector used to interface the SD301C to the SD302C Ensemble Averager.

J14 — 36-pin connector used to interface the SD301C to the SD304 and SD306 Signature Ratio® Adapter, SD307 Low Frequency Translator and for external sampling control.

J15 — 36-pin connector used to interface the SD301C to the SD303 Spectrum Translator (and other duties as assigned).

J22 — MEMORY OUTPUT — Time compressed, high speed version of signal input; repetition rate 100 μ seconds.

J25 — POSITION MARKER — Provides a marker pulse for frequency component, quick viewing identification; controlled independently by % FULL SCALE switch.

J26 & J27 — PEN LIFT — A contact closure is furnished during PLOTTER modes of operation

ANALYZER/MEMORY PARAMETERS

Upper Frequency Limit (Hz)	Memory Period (sec.)	"Resolution" (spacing of filter locations) Hz	3 dB Filter Bandwidth (Hz)	Effective (noise) Bandwidth Hz	Equivalent Speedup
50,000	0.01	100	150	160	100
20,000	0.025	40	60	64	250
10,000	0.05	20	30	32	500
5,000	0.1	10	15	16	1,000
2,000	0.25	4	6	6.4	2,500
1,000	0.5	2	3	3.2	5,000
500	1.0	1	1.5	1.6	10,000
100	5.0	0.20	0.3	0.32	50,000
50	10.0	0.10	0.15	0.16	100,000
10	50.0	0.02	0.03	0.032	500,000

TABLE I.

COMPUTER COMPATIBLE INSTRUMENTS

Many functions of the standard SD301C Real Time Analyzer can be controlled externally. These include external sampling capability, control of memory update conditions and certain modes of transient analysis. When used with the SD 302C Ensemble Averager, TTL compatible digital outputs are also furnished which may be directly coupled to many computers. For applications where the Analyzer is to be coupled to a computer without the use of the Ensemble Averager, the Model SD301C-12 is available. The "-12" is a variation of a standard Model SD301C in which a 10-bit on-line digital output of the Real Time spectrum data is made available at a rear connector. The necessary flag and sync pulses are also furnished simplifying the acquisition of Real Time narrowband spectra for further computer processing.

For complete computer control of a Real Time spectrum analysis process, the Model SD301C-C Real Time Analyzer is an optimum choice. In this stand-alone analyzer the frequency range, input voltage range, output gain and complete frequency axis sweep can be externally controlled through a simplified input command structure. The SD301C-C can be returned to standard Real Time analysis operation through simple actuation of the front panel LOCAL/REMOTE control shown in Figure 4A. Simple algorithms for automatic signal level ranging, detection of levels above selected thresholds and automatic search for a specific component can quickly be established using the SD301C-C Real Time Analyzer and a mini-computer. One such system utilizing a Nova computer is shown in Figure 4B. Many other configurations, including the PDP11/05, can be provided with the Series SD1007C Automatic Data Processing Systems. For processing spectrum outputs directly from the SD301C-C, the "-12" option may be added to provide complete analyzer control and simplified digital interfacing, the SD301C-C-12.

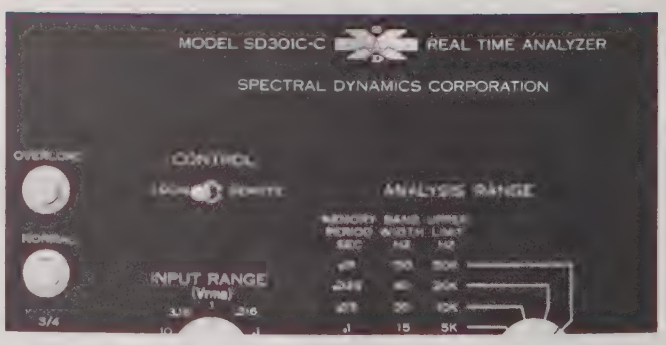


FIG. 4A. LOCAL/REMOTE CONTROL

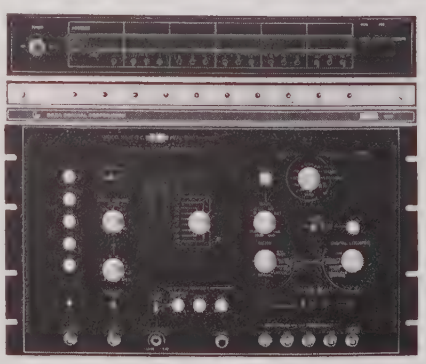


FIG. 4B. SD301C-C WITH NOVA

STATISTICAL ESTIMATES (PSD) OR SIGNAL-TO-NOISE ENHANCEMENT

For data acquisition situations which require an estimate of the average spectral content of a random signal, the SD302C Ensemble Averager (Fig. 5) provides rapid, reliable spectral density measurements. Data that is being processed on-line by the Real Time Analyzer is transferred to the Ensemble Averager (Fig. 6) where selected time periods of the data are digitally averaged.

The average level of a stationary random data signal approaches a mean value during the averaging process. The statistical quality or confidence level of the data signal is thereby improved and is directly related to the number of ensembles averaged or the time over which averaging is taking place. Signals that are periodic in nature can be unmasked from random signals during the averaging process providing detection enhancement. Signals that are "buried in the mud" can be detected by the averaging process.

The SD42 Memory (Fig. 7) provides a second memory for the Ensemble Averager. Its plug-in design makes the "dual" memory capability optional. Its flexible operational modes include automatic or manual transfer of the "averaged" spectra. "Unaveraged" or transient response data may also be stored, viewed or plotted. A calibration spectrum or signal may be stored and referred to at any time during the data acquisition task.

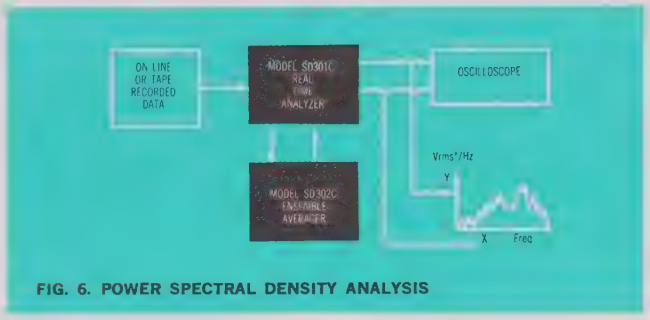


FIG. 6. POWER SPECTRAL DENSITY ANALYSIS

FIG. 5. MODEL SD302C ENSEMBLE AVERAGER

FIG. 7. MODEL SD42 MEMORY

TURBINE, ENGINE AND MACHINERY ANALYSIS

To establish the vibration pattern or "signature" of a turbine or other rotary driven device, a narrowband vibration analysis is indispensable. Using the SD301C such a snapshot can be obtained in seconds. However, during a spectrum scan, the nominal engine speed may tend to wander somewhat or it may be desirable to compare vibration patterns on two or more runs of the same engine at different speeds. Since most diagnostics and vibration pattern analyses attempt to pinpoint exact causes of vibration (which are usually related to a known gear ratio or vibration order), a full diagnosis requires a close measurement of reference shaft speed.

The SD304 Signature Ratio® Adapter, used with the SD301C Real Time Analyzer, automatically measures *and compensates* for reference speed changes (Fig. 8 and 10). It is thus a simple matter to interpret rotational vibration components since the display abscissa is always normalized to a given rotational order, not frequency or RPM.

The SD304 Signature Ratio® Adapter provides controls which take into account approximate rotational speed, rotor/tach ratios, the number of Signature Ratio® orders desired and the spectrum resolution necessary. SD304 outputs automatically control the SD301C Real Time Analyzer in order to maintain the spectrum display on a completely normalized basis. Front panel SD304 indicators warn if the SD304 "tracking range" has been exceeded. An analog voltage proportional to RPM is also furnished for direct recording of specific orders of interest as a function of speed change.

The SD306 Signature Ratio® Adapter (Fig. 9) works in much the same way as the SD304 in that it automatically measures and compensates for reference speed changes allowing the Real Time Analyzer output display to be "order" related vs. amplitude. The units

FIG. 8. MODEL SD304 SIGNATURE RATIO® ADAPTER

FIG. 9. MODEL SD306 SIGNATURE RATIO® ADAPTER

TURBINE, ENGINE AND MACHINERY ANALYSIS (continued)

differ in that the SD306 incorporates a tracking low-pass or anti-aliasing filter over its full 130/1 speed range. The data signal is applied directly to it rather than to the Real Time Analyzer. Provisions are available, as a result, for front selection of full scale orders. Simply dial 5, 10, 20, or 40 orders full scale for display. Also selectable from the front panel is the tach pulse rate. Tach rates of 1, 2, 3, 4 and 60 pulses per revolution can be selected. Different combinations of pulse rates and full scale orders can be used.

A tach sensitivity adjustment is provided for "sync" of a wide variety of tach signal sources as well as tach levels. For recording the amplitude of a specific order as a function of speed change, a voltage proportional to RPM is available. As an example, the amplitude of the 6th order of rotational speed can be plotted on an X-Y recorder over a specified RPM range.

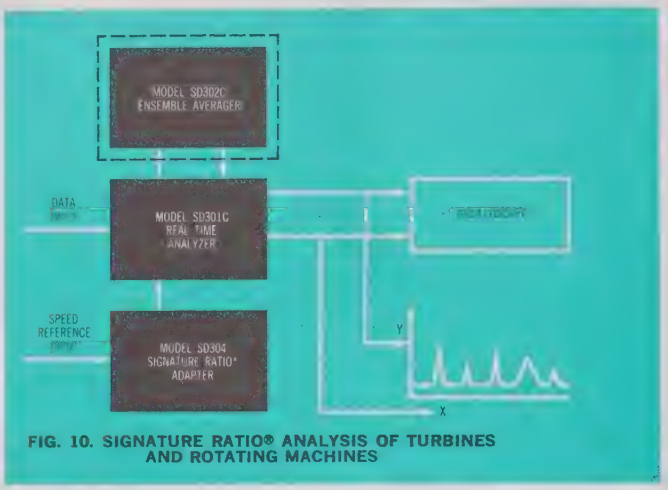


FIG. 10. SIGNATURE RATIO® ANALYSIS OF TURBINES AND ROTATING MACHINES

RECORDING TIME VARYING SPECTRA

The extreme analysis speed of the SD301C makes it one of the first means available for examining the "on-line" spectrum of signals. The direct output of the SD301C Real Time Analyzer, in terms of the Fourier content of the signal input, may be viewed on an oscilloscope and recorded for permanent copy. For instant identification of frequency components, a typical facsimile recording is illustrated in Figure 11. The record also shows the 10 internal frequency markers from the SD301C. A three-dimensional presentation of amplitude, frequency and time or RPM is thus readily available. Note that amplitude is a function of intensity on this type of record.

For "quick viewing" three-dimensional presentations of time varying data, the SD25-80 3-D Display Control (Fig. 12) is available to work in conjunction with the SD301C Real Time Analyzer and a storage oscilloscope or other recording device. The 3-D Display Control

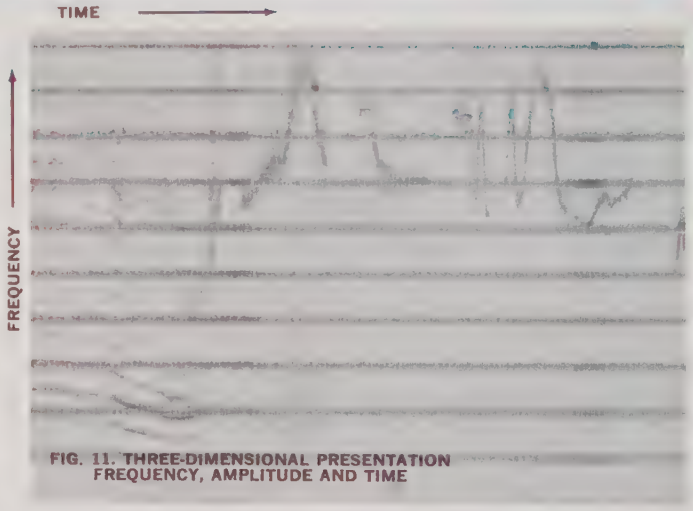


FIG. 11. THREE-DIMENSIONAL PRESENTATION FREQUENCY, AMPLITUDE AND TIME

provides for visual Fourier spectrum displays of amplitude (Y axis), frequency (X axis) and time (Z axis) as illustrated in Fig. 13. Amplitude and frequency can be displayed either linearly or logarithmically. Another mode of operation provides for intensity being varied as a function of amplitude versus frequency versus time or RPM for display. Many variations of these displays are possible providing on-line monitoring of data as it occurs with a time history being preserved. Among a wide range of applications is speech analysis, signal detection, machinery diagnosis and as a troubleshooting or preventative maintenance guide. Permanent records of the data are easily obtained in the form of a scope-camera photograph or a typical 8½" x 11" "hard copy."

FIG. 13. TYPICAL THREE-DIMENSIONAL PRESENTATION OF "MACHINERY ANALYSIS"

FIG. 12. MODEL 25-80 3-D DISPLAY CONTROL

FREQUENCY TRANSLATION — High Frequency Narrowband Resolution

The SD303 Spectrum Translator (Fig. 14) is a standard accessory designed to provide narrowband analysis to frequencies as high as 1 MHz. The SD303 accepts data signals in the frequency range of 2kHz to 1 MHz and translates them down to a compatible input frequency range of the Model SD301C. The reference "folding" signal must be supplied from an external oscillator.

Signals with frequency content as high as 1 MHz can be translated to the 2, 5, 10 or 20 kHz range of the SD301C providing analysis bandwidths of 6, 15, 30 or 60 Hz respectively. By using a stable frequency synthesizer as the reference oscillator input, precise measurement of harmonic content and spectrum signatures up to 1 MHz are quickly and accurately made.

The SD307 Low Frequency Translator (Fig. 15) is a newly developed unit designed to provide even finer bandwidth resolution at frequencies as high as 50 kHz. This unit has an internal reference source that can be stepped in 1 Hz steps to 10 kHz and 10 Hz steps to 50 kHz. The reference oscillator can be programmed remotely for a completely automated "systems" approach. An external synthesizer may also be used as the reference source and analysis up to 99 kHz obtained. Data signals occurring in the frequency range to 50 kHz can be translated to the 50, 100, 500 or 1,000 Hz range of the SD301C Real Time Analyzer offering analysis bandwidths of 0.15, 0.30, 1.5 or 3 Hz respectively, as shown in Fig. 16.

A tremendous signal-to-noise enhancement capability is available with the translation technique. As an example, consider an analysis bandwidth of 0.3 Hz being used to 50 kHz to resolve data signals. The detection capability is related to the ratio of the data bandwidth

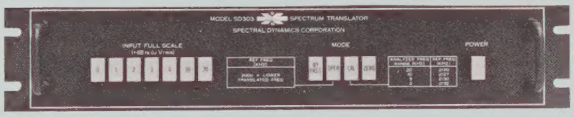


FIG. 14. MODEL SD303 SPECTRUM TRANSLATOR

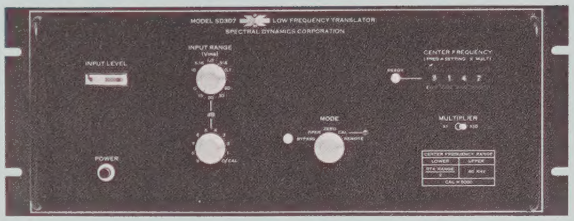


FIG. 15. MODEL SD307 LOW FREQUENCY TRANSLATOR

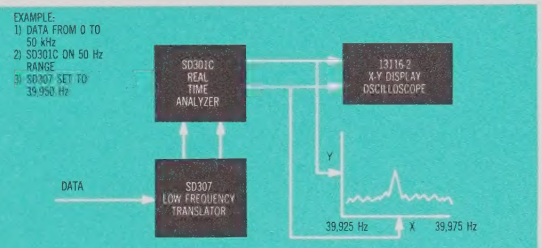


FIG. 16. "ZOOM-IN" NARROWBAND RESOLUTION

to the analyzer bandwidth ($E_{in} \times \sqrt{\frac{0.3}{50{,}000}} = E_{out}$) in that the noise contribution of the broadband signal is attenuated (≈52 dB in this example). Any periodic or harmonically related signals are not attenuated and are, therefore, easily detectable. Averaging of the translated data can further enhance the data acquisition task.

The SD303 Spectrum Translator and the SD307 Low Frequency Translator can be cascaded offering increased capabilities for high frequency analysis. Other translators are available for use with the Real Time Analyzer or sampled data processing systems. Specific details on these will be provided upon request.

ACOUSTIC DATA ACQUISITION

The SD305A Octave Converter provides constant percentage conversion by digital processing of the narrowband data obtained with the Real Time Analyzer. Equivalent 1/1 or 1/3 octave filter displays are possible where reference to noise criteria based on octave bands is required. (See Figures 17 and 18.) In the 1/3 octave display mode, twenty-one 1/3 octave bands are provided. By utilizing all of the Real Time Analyzer frequency ranges, up to fifty-seven 1/3 octave bands (covering 0.1 Hz to 40 kHz) are available. Capabilities of the SD305A include on-line or continuously updated 1/3 octave displays, averaged 1/3 octave displays and a "peak hold" mode of operation in which the largest time varying spectral contributions are continuously displayed. Its digital computation and log conversion provide for optimum accuracy, stability and dynamic range. A digital output (parallel binary words—TTL compatible) allows the Octave Converter to be interfaced with a computer for further data processing applications. A selected narrowband or 1/3 octave band can be intensified via thumbwheel control.

The 13116-2 X-Y Display (Fig. 19) provides a large screen monitor for enhanced Real Time Analyzer data processing. It offers rapid selection of either linear or logarithmic display of both frequency (X)

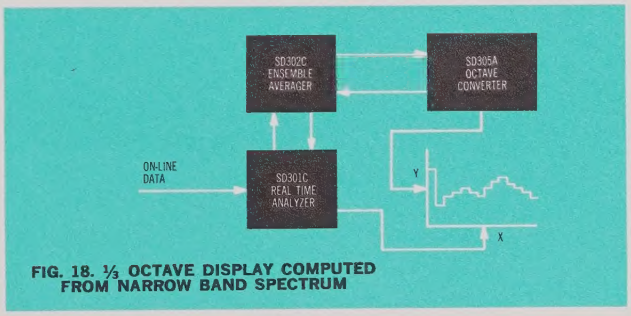


FIG. 18. ⅓ OCTAVE DISPLAY COMPUTED FROM NARROW BAND SPECTRUM

and spectrum amplitude (Y) information. The large screen (8"x10") lends itself to accurate frequency and amplitude determination at a glance. Monitoring of on-line, continuously averaged, or 1/3 octave data, etc., is enriched.

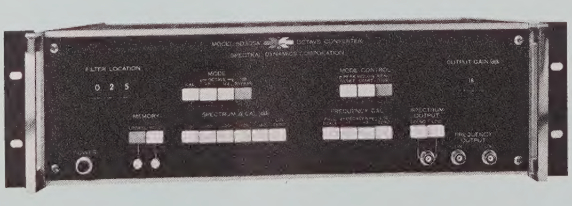


FIG. 17. MODEL SD305A OCTAVE CONVERTER

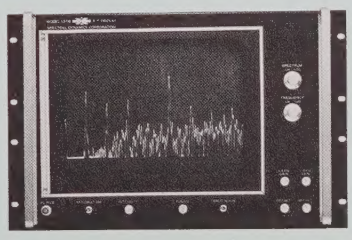


FIG. 19. MODEL 13116-2 X-Y DISPLAY

SPECIFICATIONS

MODEL SD301C REAL TIME ANALYZER

INPUTS

Frequency Range, Selectivity ..... 10 Ranges to 50 kHz (See Table 1, Page 4)

Sensitivity ..... (for full scale output) 0.1 Vrms to 28.2 Vrms adjustable in 1 dB steps (AC/DC input coupling)

Level Indication .... 5 digitally driven indicator lamps provide correct indication of input level regardless of waveform

Impedance ..... 100 kΩ

Dynamic Range ..... (full scale to minimum discernible signal) 54 dB

Noise Level ..... At least 60 dB down from full scale

Frequency Markers .. 10 equally spaced markers—or external input (Note: internal markers are attenuated in upper Gain positions to prevent overload)

OUTPUTS

Spectrum (Y-axis)

RTA Lin Step .... 0 to 5 V RTA detector output; one step for each synthesized filter location regardless of Ext Avgr being selected

Lin Step ..... 0 to 5 V detector output

Lin ..... 0 to 5 V (nominal) smoothed output of detector

Log ..... 1 V (nominal) log smoothed output of detector

Memory Contents ... 500 mV p-p full scale signal displaying the analog replica of speeded up signal stored in memory

Impedance ..... (Spectrum and Frequency outputs) Nominally 600 ohm maximum

Frequency (X-axis)

RTA Lin Step .... 0 to 5 V stepped ramp regardless of Ext Avgr being selected

Lin Step ..... 0 to 5 V stepped ramp

Lin ..... 0 to 5 V (nominal) smooth ramp

Log ..... 1 V (nominal) smooth log ramp

Sweep Trigger .... A change from 5 V to 0 V is synchronized with start of sweep — returns to 5 V at the end of sweep

Retrace Blanking .. A zero to +5 V level is furnished between the end of each analysis sweep and the beginning of the next

Position Marker .. Separate output pulse (5 V) for frequency component identification controlled by % Full Scale switch

MISCELLANEOUS

Modes of Operation (May be selected manually or remotely)

Update ..... Memory continuously updates with fresh input data—new spectra are continuously displayed

Hold ..... Last data in memory is continuously recycled—no new information is added. Spectrum of time function in memory displayed repeatedly

Transient Capture . The memory is loaded—then Hold mode is automatically selected. Triggering of transient capture mode (start of load cycle) may be done either externally via separate pulse or from the data itself

External Control of Operational Mode . Application of an external d-c level (nominally 5 V, 2 microseconds minimum duration) to either the Update, Hold or Transient Capture input will automatically cause the selected mode to be activated

Internal Calibration . Calibrates entire analyzer from signal input to d-c outputs

Y-Axis ..... (LIN) Full scale and zero (LOG) Full scale, −10 dB, −20 dB, −30 dB, −40 dB

X-Axis ..... (LIN) Full scale and zero (LOG) Full scale, −1 decade, −2 decades

Sweep Speed

Oscilloscope fast .. A new sweep is initiated every 50 msec giving a "flicker free" oscilloscope display

Oscilloscope slow .. A new sweep is initiated every 0.1 sec by stepping the synthesized filter in ½ normal steps

Plotter ..... A plot is completed in 32, 64 or 320 seconds (internally set) or as affected by sweep rate feedback

Frequency Linearity . ±0.2% of best straight line of full analysis range

Power ..... 105-125/210-250 V ac (switch-selectable); 50 to 60 Hz; ≈ 175W; (≈195W for SD301C/SD302C combination)

External Averager ... Sweep rate is placed under control of SD302C either Scope Fast or Plotter as selected on the SD302C

Manual ..... Filter position is controlled by % Full Scale switch

Sweep Initiation

Automatic ..... Spectrum output is presented repeatedly, one after another

Single/Reset ..... A complete spectrum is presented each time a trigger pulse is provided or each time the sweep trigger button is depressed

Memory Period ... A sweep is initiated each time a memory load cycle is completed. Each spectrum display is statistically independent of the previous display and redundant spectra are eliminated

Frequency Response . ±1 dB over entire frequency range

Linearity of Spectrum Output . ±½% of full scale or ±1 dB, whichever is greater

Separation ..... Two equal amplitude sinusoids, spaced 2 filter bandwidths apart, when applied simultaneously to the SD301C will exhibit an average 6 dB valley between the spectral peaks

Selectivity ..... Filter response is at least −20 dB at a frequency removed from center frequency by 2 bandwidths and −40 dB at 4.5 bandwidths, ±15%

Digital Locator ..... (Controlled by 3-decade thumbwheel switch)

Intensity Marker .. Provides intensified markers (1 or 10) for frequency component identification in scope modes

Sweep Limit ..... Provides for limited sweep and shortened display times in scope and plotter modes. (Less than 500 lines are examined)

Transient Capture . Provides control of memory contents, function of direct reading of dial, 1 to 999. A 000 setting blocks loading the memory

Dimensions ..... Height—26,6 cm (10½″)
Width 18,3 cm (19″)
Depth 53,3 cm ((21″)
Shipping Weight 27,2 kg (60 lbs.)

ACCESSORIES SUPPLIED

Power cord, multi-pin mating connectors, two manuals

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